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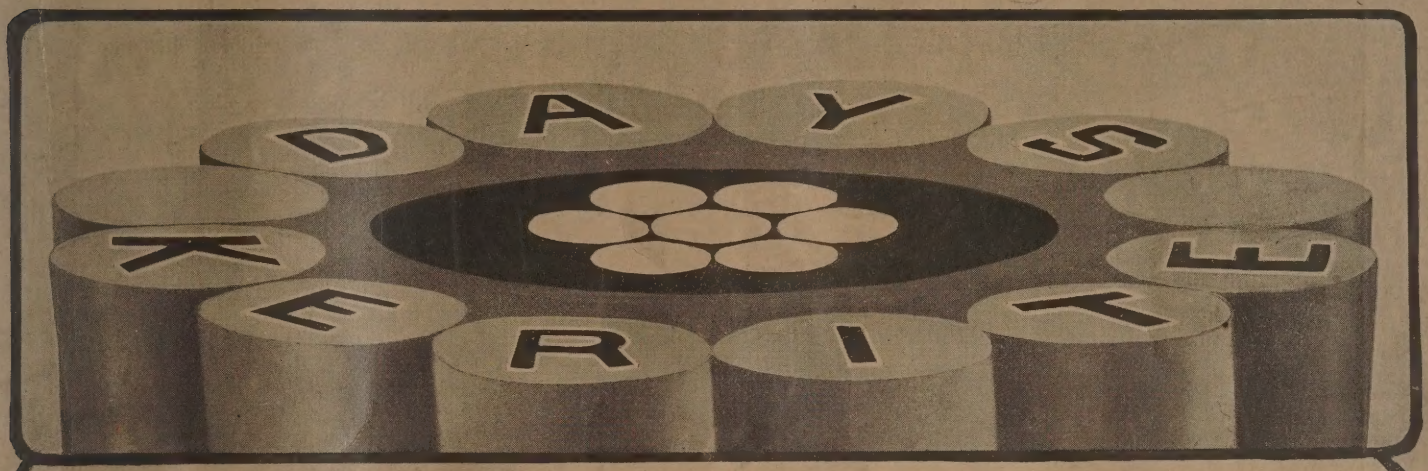
# RAILWAY ELECTRICAL ENGINEER

The Official Journal of the Association of Railway Electrical Engineers

Vol. 2 | CHICAGO 92 La Salle Street | AUGUST, 1910 | $1.00 per year Domestic—$1.50 per year Foreign 10 Cents per Single Copy | No. 3



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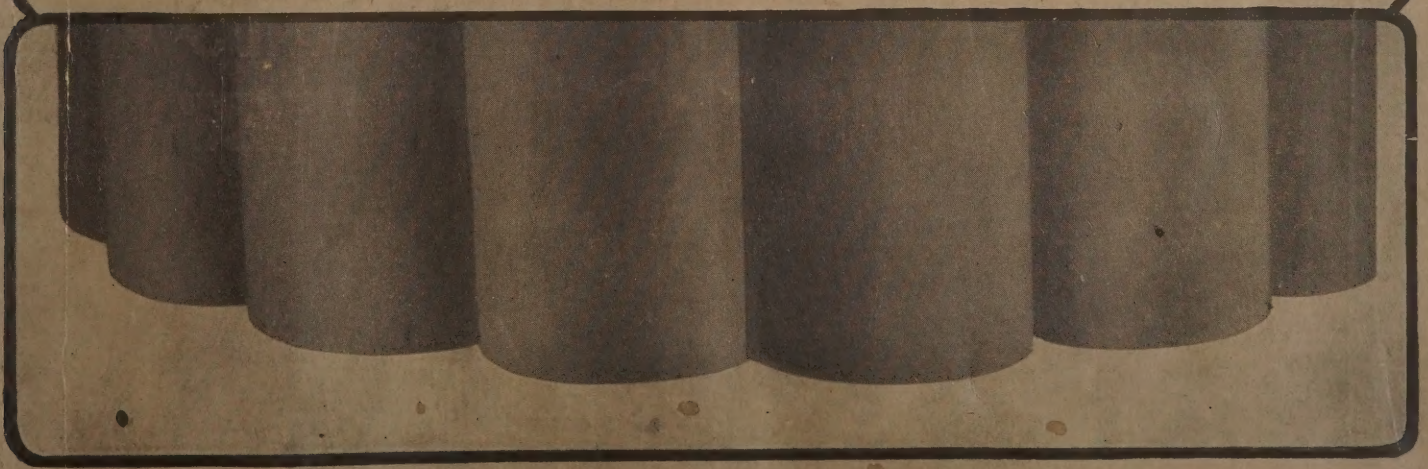

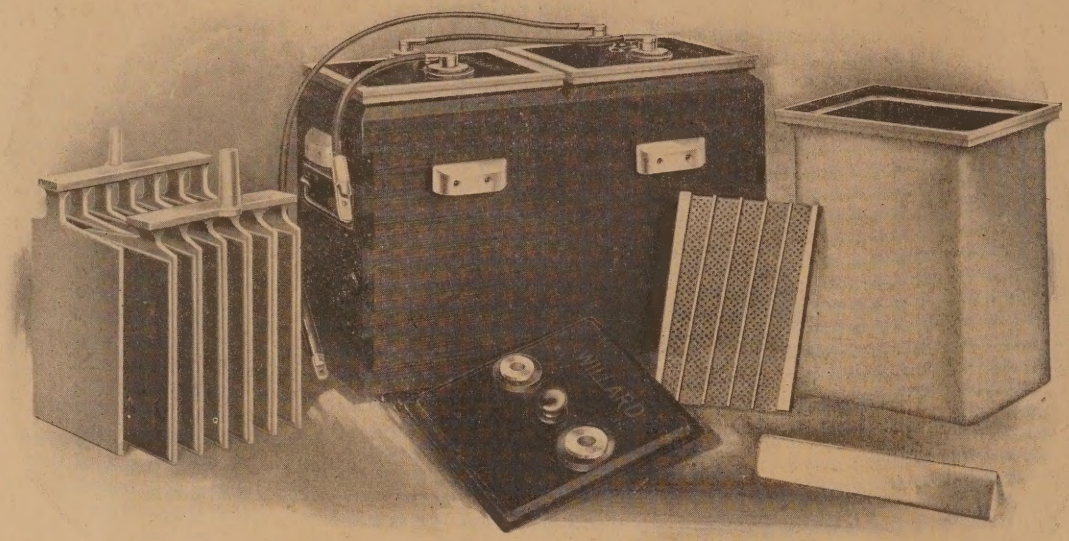


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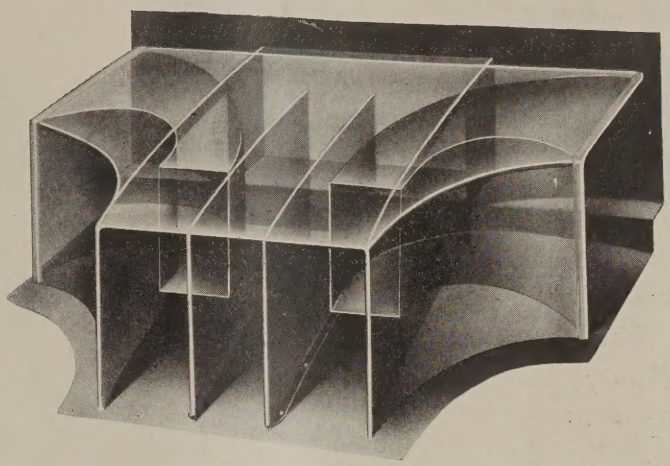

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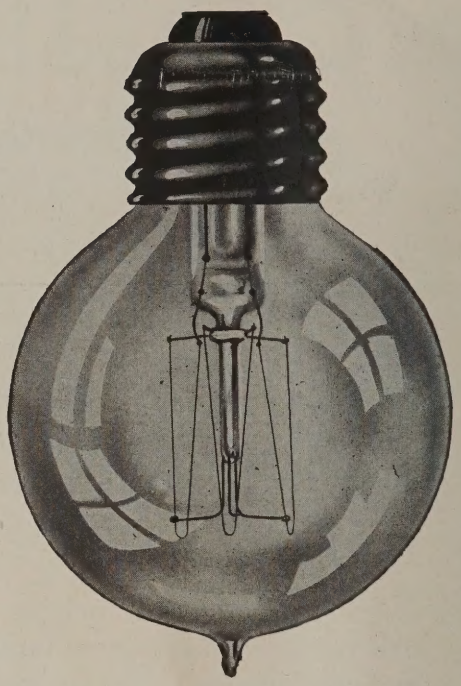

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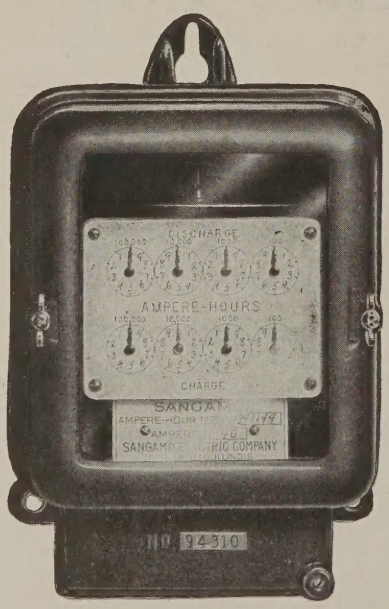


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When applied to the operation of straight storage equipment the saving in current effected by the meter over that required when charging by the gravity method, will pay for the meter in three months.

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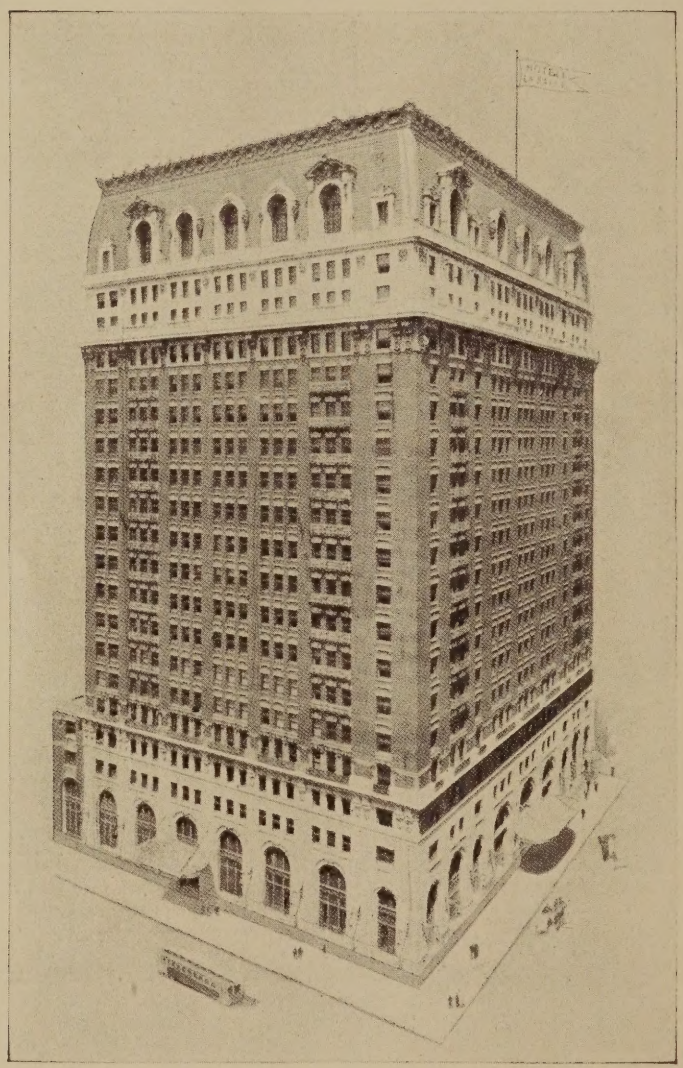

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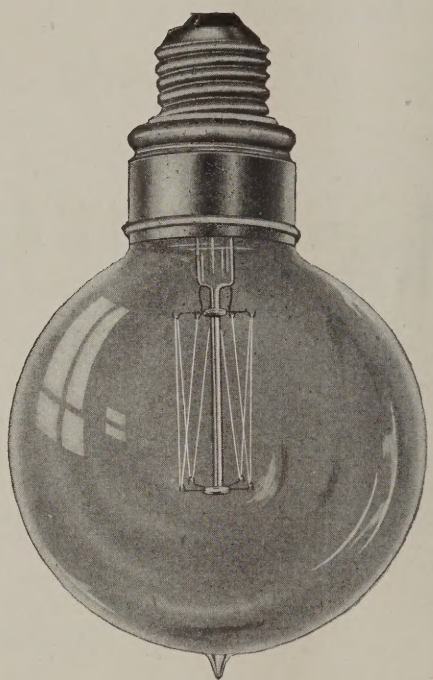

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which is of such great importance in the operation of car lighting batteries, can be traced from such factors as manufacturing experience, engineering ability, quality of material and results accomplished.

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## The Railway Electrical Engineer

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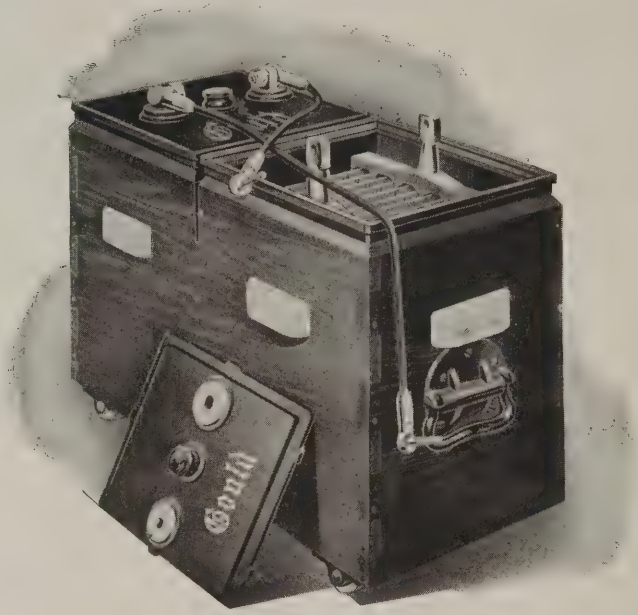


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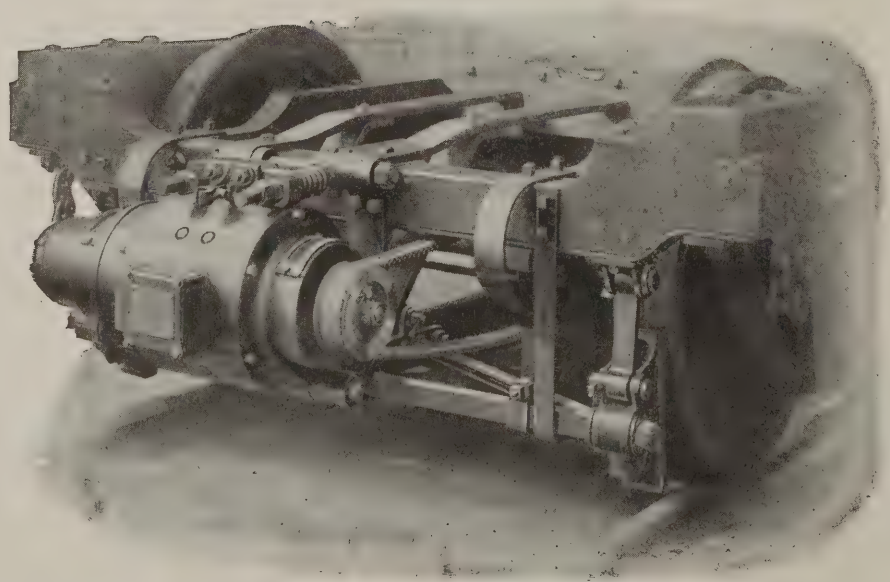

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# RAILWAY ELECTRICAL ENGINEER

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

WRAY PUBLISHING CO.

PUBLICATION OFFICE
92 LA SALLE ST.
CHICAGO

Telephone Main 2457.

EDWARD WRAY . . . President and Managing Editor
J. G. WRAY . . . . . Secretary and Treasurer
RALPH BIRCHARD.....Associate Editor

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

TERMS OF SUBSCRIPTION

United States, Canada and Mexico . . . Per Year, $1.00
Other Foreign Countries within the Postal Union . " " 1.50
Single Copies, Domestic . . . . . 10 cents
Single Copies, Foreign . . . . . 15 cents


OUR OBJECT.

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


Editorials—
A Vital Question..... 45
En Route Car Cleaning..... 45
The Long Step..... 45
The Coming Convention..... 46
The Car Lighting Club..... 46
Next—The Machinery Number..... 46
The Ventilation of Railway Passenger Cars..... 47
Chicago Health Department Tests..... 49
Car Ventilation with the Jandus Gyrofan..... 51
The Electrification of Steam Railways..... 52
Improvement of Electric Lighting in Old Cars..... 56
The New Edison Storage Battery..... 60
Deterioration of Steel Conduit in Car Lighting Service..... 63
Practical Stunts by Practical Men..... 64
General News and Personal Mention..... 65
Patents ..... 12
Association Directory ..... 15


## A VITAL QUESTION.

A MAN can live thirty days without food, ten days without water, three minutes without air. Air is the most essential thing in the world to the health—to the very life of humanity, the most plentiful and yet the most precious. The ventilation question is a vital question.

How many people do you suppose are on railway cars at this moment? The figures are amazing. You wouldn't believe them if you heard them. Taken in a large way the most active, energetic and progressive people of the world are its greatest travellers. It is, then, extremely important that they should breathe pure air.

We are just beginning to realize that travellers have not always been and are not being today provided with the pure air that is their due. It is within the last few years that any effort has been made to provide for car ventilation. But the demand for it is growing so fast that the shops cannot change the cars fast enough. It will continue to grow. It should continue to grow.

The science of car ventilation is in its infancy. The next ten years will see a greater development than has taken place in the last fifty. We are glad indeed to devote this issue to a subject so vital as this one.

## EN ROUTE CAR CLEANING.

WHEN people traveled over the country in stage coaches, they traveled for business, not for pleasure, and if their faces were unrecognizable at the end of the trip on account of the landscape they had accumulated, it was all part of the day's work.

With the advent of the steam railroad, came the idea of going somewhere for the fun of it. Steam cars ran so much faster than the old horse-haul vehicles, that for quite a while nobody had the nerve to object to the cinders, dirt and dust. But now, when the general passenger agent considers an electric curling iron such an inducement to prospective passengers that he is willing to spend a lot of the company's good money advertising it, the day of the en route car cleaning is certainly at hand.

Of course there is nothing new in the idea of keeping the cars clean but up to now there has been no really effective method of doing so. The well meant efforts of the perspiring porter do not as a rule accomplish anything more than to transfer the dust from your shoes to your collar.

It is the application of electricity to passenger trains that has made possible a system of en route car cleaning which really does what it sets out to do. All the vacuum cleaners on the market, and there are any number of them, use electrically driven fans or pumps to exhaust their vacuum chambers. It is probably hardly necessary to enter into any discussion or explanation of the principle of the vacuum cleaner. It is fast coming to be a household necessity like the sewing machine is, and the carpet sweeper was, until recently. Suffice it to say that instead of stirring up the dust, the vacuum cleaner gathers it in—"swallows it"—as an ingenious advertising writer has said.

It is partly because electricity is essential to the operation of these cleaners that the different systems have been given the space they occupy in the present issue. But it is also because the subjects of car lighting, heating and ventilation are so intimately connected that all come naturally within the field which this paper covers.

Mechanical en route car cleaning is a new thing but is a thing which is here to stay, at least until we get electric traction, and that from present indications is a good long time.

## THE LONG STEP.

THE greatest obstacle in the way of electrification of steam railways today is the lack of a standard for electrical operation and equipment. Three systems of electrical operation so fundamentally different that the machinery in one of them cannot possibly be altered or made over to fit the others, are in use today on American steam railways. Each has its advantages and its advocates. Possibly no one of the three is the best in every respect. But, as Mr. George Westinghouse pointed out in his recent address on this subject, if a decision could be reached as to which one was the most generally de-

sirable, the efforts of the thousands of workers in the field could be focused on the problem of how to perfect this one system. The result would be that one system would soon be brought to such a point of perfection that as a matter of pure business economy its general adoption would be assured.

Until some standard is agreed upon it is futile to urge the general electrification of steam railways. No railroad can be expected to invest in equipment which may soon become valueless owing to the general adoption of another system, or improvements in one which make the system in use obsolete and unprofitable to operate.

The life of electrical apparatus is brief at best. Designs change constantly; the latest thing is the most approved. Usually it is the best, but because this is so often true, much useful equipment finds its way into the scrap heap. Standards are just beginning to crystallize out of the mass of conflicting claims, charges, and characteristics.

Who shall fix the standards for electrical equipment? Who shall weigh the evidence for and against direct current with high tension transmission, single phase, single trolley, alternating current, and polyphase alternating current with double trolley wire? Obviously no single railway or group of railways or manufacturers, nor even any of the engineering societies, is big enough to pass judgment with the authority which such a tribunal must necessarily have.

A conference made up of the heads of the leading railways, manufacturers and engineers of the country having at its disposal the best expert knowledge both here and abroad might properly draw up standards and, by supporting them individually, make sure of their general adoption in the shortest possible time.

The sooner such a conference is formed the nearer will be the day of universal electrical operation of railways. And until it acts no general movement for electrification can be expected. The adoption of a standard interchangeable electrical railway equipment will be a long step forward—the next long step, and perhaps the longest step of all.

## THE COMING CONVENTION.

SEPTEMBER 27th-28th-29th-30th will see the largest gathering of Railway Electrical Engineers ever held in this country. These are the dates recently decided upon for the Annual Convention of the Association in Chicago at the La Salle Hotel.

Every phase of the work of the railway electrical engineer wil be discussed at this meeting. Committee reports embodying the latest information in all lines of the electrical activity in railways will be presented for the consideration of the convention. In the discussion of these reports and of the other papers dealing with special features of the work, much new and valuable material will be brought to light. As an educational institution this convention will rank with the post-graduate courses in the colleges of Engineering.

As at all railway conventions, the manufacturers exhibits will constitute one of the most important sources of information. The exhibits this year will be more extensive and complete than ever before. Many new firms will be on hand with different, and perhaps hitherto unheard-of improvements, while all the old companies will show the latest developments in their lines.

Perhaps we are laying too much stress on the business side of this convention. Rest assured that the social side will not be neglected. The arrangement committee is planning a series of stunts that will be among the most enjoyable of any you ever attended. Apart from these there is no finer stimulus to increased effort than a chance such as this convention affords to meet men from all parts of the country engaged in the same work, meeting and overcoming the same difficulties, striving toward the same high ends.

No one engaged in this work, either as a manufacturer or a railway man can afford to miss this opportunity to broaden his associations in the field and acquaint himself with the latest developments in railway electrical matters.

Remember!

Annual Convention of the Association of Railway Electrical Engineers.

Time—September 27-30. Place,—La Salle Hotel, Chicago.

**Joint Committee on Convention Arrangements.**

A. J. Farrelly, Elec. Engr., C. & N. W. R. R., Chairman.
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W. E. Ballantine, Willard Storage Battery Co.
J. M. Lorenz, Central Electric Co.
C. W. Bender, Nat. Electric Lamp Ass'n.

## CAR LIGHTING CLUB.

THE car Lighting Club will meet September 7th in the main dining room of the Chicago Press Club at 118 Dearborn Street. There wil be received at this meeting the report of the Committee on Voltage Regulation and Illumination. This committee consists of:

N. E. Lemmon, Electrical Engineer, Pullman Car Co., Chairman.

Geo. R. Shirk, Electrical Engineer, C. & G. W. Ry.

H. G. Myers, Electrical Foreman, A. T. & S. F. Ry.

After a rest during the hot months of the summer the Club will no doubt be out in force and make this one of the most interesting sessions in its history, thereby starting off the year with enthusiasm. The Car Lighting Club is bound to be one of the biggest factors in the development of the art of the illumination of railway cars, and in such pleasant surroundings as the Press Club affords, the meetings will continue to be a source of pleasure as well as profit.

## NEXT—THE MACHINERY NUMBER.

THE electrical engineer on the railway of today has to deal with three distinct applications of electricity: Lighting, Traction, Machinery. Our next number will deal chiefly with the uses of electricy in railway shops and yards.

Motor drive in shops has immense advantages over the old style line shaft drive. It delivers power at exactly the required speed and for the length of time when it is needed. It is better controlled, less dangerous, more economical. It is fast forcing the old style transmission into the scrap heap. The day of almost universal use of electricity will soon be here.

In handling and transferring freight, operating coaling and pumping stations, and supplying power for a hundred different uses in railway yards there is a vast field of usefulness for electricity.

The electrical operation of all the machinery is a live topic—as live a topic as there is in the railway world. We are glad, indeed to be able to announce a thorough discussion of it in the September RAILWAY ELECTRICAL ENGINEER.

And while we are talking about the future it might not be out of place to say that the October Convention number is going to make some people sit up and take notice. More about that next time.

# The Ventilation of Railway Passenger Cars

## The Problem; the Principles Involved; Some Salient Features of the Systems Used

It is not at all unlikely that the average person would say that a railway car was of all the places in the world the least in need of ventilation. He thinks of it as rushing through space—windows open, draughts of air blowing his newspaper out of his hands, everywhere moving air—smoky and cinder-laden air, it is true, but still air, never. He does not, perhaps remember the close stuffiness of the sleeper when he climbs into it in the dark train shed, or the warm, moist, fetid atmospher of a chair-car full of sleeping passengers on a winter night, or the smoking room where tobacco fumes lie thicker than a London fog. If he will recall these experiences he may agree that there is possibly a ventilation question, but if, on the other hand an electric fan stirred up the air in the end of his sleeper as he entered it or if the chair-car was cold and draughty and the smoking room a veritable ice box where the smokers sat bundled in overcoats watching the tips of their cigars glow and splutter in the icy wind, he will probably say that there is plenty of ventilation "to say the least."

The reason for this is a wrong impression of what ventilation, or rather what good ventilation, is. Strong currents of air, "fresh" or otherwise, do not make up good ventilation. Cold air is not necessarily pure. Rushing draughts of hot dusty air in summer or cold snowy air in winter may contain the necessary oxygen but they do not produce good ventilation.

### Good Ventilation.

Good ventilation may be defined as the delivery into the car of outside air free from unusual impurities, and at the correct temperature and such a pressure or velocity as to be imperceptible in its movement.

One thousand cubic feet per hour per person may be regarded as an adequate supply for persons traveling as they are, of course, always sitting down or at least standing still—not exercising. This means that a fully loaded sleeping car, containing forty sleepers should receive 40,000 cubic feet per hour, while some of the largest coaches should have facilities for taking in nearly twice that amount.

To be free from unusual impurities means without those impurities which are given out by the locomotive, cinders, smoke, soot, or stirred up by the train dust. The air in the train should be as nearly as possible the same as that a hundred feet away from it outside the right-of-way fence. At the correct temperature means ordinarily 72 degrees Fahrenheit for a sitting car and 66 for a sleeper. Such velocity or pressure as will be imperceptible means that not even the most feeble lady passenger will ever feel a draught.

This standard of good ventilation is accepted by all the workers in the field today and each system of car ventilation in use strives to meet the requirements outlined above.

### How It May Be Secured.

All of the systems at present in use or possible to be devised may be grouped under two heads: 1, Natural Systems; 2, Artificial or Mechanical Systems.

The first group make use of the movement of the air relative to the car to force some of the outside air into it. The most simple and by far the most common is the open door or window, supplemented by the small draught window, or ventilator, placed near the top of the car. It is quite unnecessary to say that these do not give good ventilation. Draughts go inevitably with their use and the cars are filled with smoke and cinders at the end of a few miles run.

Others, such as the Garland type, are small boxes placed on the roofs of cars through which air passes in such a way as to create an exhaust from the car. Where the air taken out by these ventilators is replaced by other air passing first over the heating coils, and where enough ventilators are installed to completely remove the exhausted air, these systems give results approximating very closely to the ideal **when the train is moving at a speed upwards of 30 miles per hour.** For speeds lower than this the ventilator is inadequate, and is therefore, best adapted only for trains running practically continuously at high speeds.

### Artificial Systems.

The second group includes two classes working on directly opposite principles. They may be called the pressure or forced draught system, and the vacuum or induced draught system. Both employ electrically driven fans either to force air in or draw it out of the car.

The first of these is like the natural system in that air is forced into the cars. It is unlike it in that the quantity of air furnished can be regulated absolutely irrespective of the speed of direction of motion of the train, and that the air can be taken from the part of the car most free from dust and smoke, instead of being placed in the line of the greatest air travel which is also the line of the greatest dirt travel.

The vacuum, or induced draught system, is the only one assuring a positive exhaust of the necessary quantity of air. The exhaust may be made through a chamber in the sides or ceiling or in the sleeper from each berth. The intakes in this system may be larger and spaced more frequently so as to produce a gentler flow, and the air may easily be made to enter the car without perceptible velocity over the heating coils, while it may be taken in either from the top or bottom of the car or from wherever there is the least dust.

Experiments made by the Health Department of Chicago on street cars indicate that there is very little dust under the body of a moving car. These experiments were made by placing a wide board, greased with vaseline crossways of the car and noting the thickness of the dust settling upon it during a run. It was found that the dust is thrown out on each side of the track. Whether this would be true of steam trains where there are a number of cars together, is problematical, but it must be remembered that the steam car floors are considerably higher from the ground.

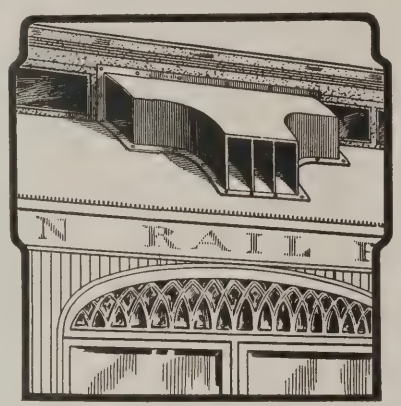
### Future Developments.

The advantages of the mechanical methods are

obvious. The disadvantages include a slightly greater first cost. The operating expense of the small fan is practically negligible. But as yet these plans are untried. Indeed it is only within the last few years that the electrical equipment of cars has made it possible they should be tried. Practically all the cars now being built are equipped for electric lighting and it seems quite probable that the time is near when they will also be fitted with electrically-driven mechanical ventilating sets giving what is now coming to be universally recognized as good ventilation.

## RAILWAY CAR VENTILATING SYSTEMS

### THE GARLAND CAR VENTILATOR.



The Garland Car ventilator as shown in the accompanying cut is one of those working on the vacuum or suction principle. The motion of the air outside relative to the car is used to create a suction in the small chamber placed on the car roof. It is claimed that this suction is strong enough in a complete installation of ten ventilators to the car to induce a continuous upward movement of the air in the car.

The manufacturers of these ventilators claim that with ten ventilators per car the following results are positively assured.

| Speed of train | Average exhaust each ventilator per hour | Total exhaust per hour (10 ventilators) |
|---|---|---|
| 30 miles per hour | 15,000 cubic feet | 150,000 cubic feet |
| 40 " " " | 20,000 " " | 200,000 " " |
| 50 " " " | 27,000 " " | 270,000 " " |
| 60 " " " | 36,000 " " | 360,000 " " |

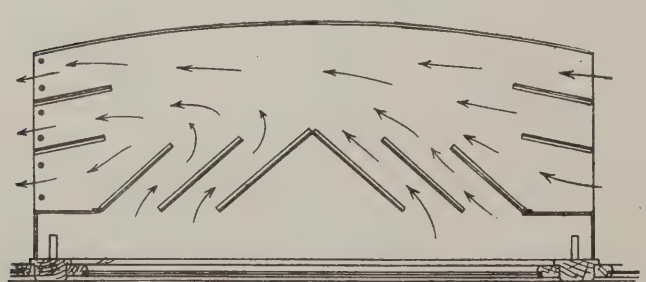
As the air capacity of the average car is about 5,000 cubic feet the above figures mean that the air in a moving train will be changed in from one to two minutes.

No smoke, dust or cinders can enter the car through this ventilator and it has no moving parts.

### THE ACME VENTILATOR.

Similar in design and principle to the one described above is the Acme Ventilator. This also, is an induced draft device in which the suction is created by the movement of the car relative to the outside air.

The chief difference between this and other ventilators is that the outside wall is solid instead of open. The advantage claimed for this type of construction is that a side wind blowing directly against the car cannot force in any cinders, snow, or other foreign matter.



Showing the Action of the Acme Ventilator.

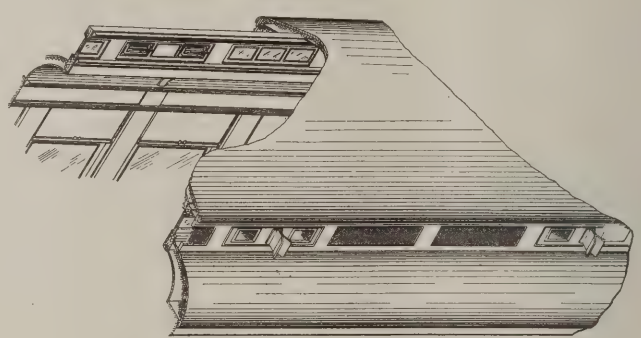
The construction is of sheet brass or galvanized iron and the ventilator lies close to the roof, occupying very little space.

### THE AUTOMATIC VENTILATOR.

A combination of forced and induced draft is secured with the Automatic Ventilator.

The forced draft is secured by means of a brass vane set perpendicularly to the wall of the car which catches the passing air and forces it into the car through a small opening fitted with regulating shutters and covered with a wire screen to prevent the entrance of cinders. This opening is placed in front of the vane. Another back of the vane is used to exhaust air from the car. The rush of air past the end of the vane creates a low pressure there which induces a current from within the car.

The openings are ordinarily 4 by 6 inches and the usual equipment on the ordinary passenger car consists of 14 ventilators—7 on each side spaced evenly along the full length of the car.



The Automatic Ventilator in Place.

This ventilator has found favor with several large eastern railway systems, but has not, as yet, been used to any extent in the west.

### A MECHANICAL CAR VENTILATOR.

The Cooke System of Car Ventilation is the only system in use at present which employs the principle of mechanically induced draft to create a circulation of air. This system has been applied to 350 city railway cars in Chicago, but has not, as yet, been installed in any steam railway equipment.

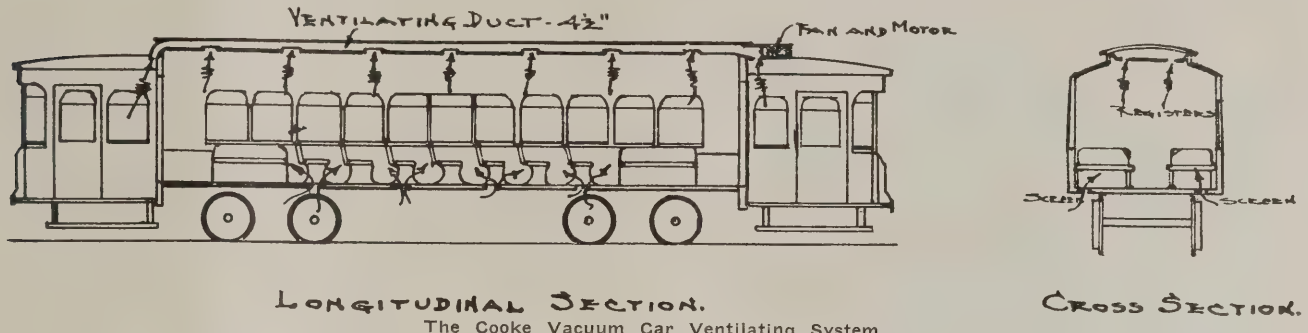
The principle of this system of ventilation is exhaustion of the vitiated air from the top of the car by means of a motor-driven fan. A false ceiling creates an exhaust chamber in the roof from which the air is drawn by a fan placed at one end. Fresh air intakes are located under the seats, so arranged that the incoming air passes over the heating coils.

The accompanying plan shows the direction of the air movement in the car. The exhaust into the top of the car takes place through small registers, and these registers are provided with dampers so that the area of the opening is varied directly with the distance from the fans. In this way an even

pressure is secured through all the registers irrespective of their distance from the fan.

The fan used is 9 inches in diameter and the air is drawn into it from the exhaust chamber through a cone-shaped duct. It is claimed that this system gives an even and constant circulation of fresh air within the car regardless of the speed, direction of motion, or outside wind pressure.

Patents for this apparatus are owned by the Vacuum Car Ventilating Co., with offices in the Fisher Building, Chicago.




LONGITUDINAL SECTION. CROSS SECTION.

The Cooke Vacuum Car Ventilating System.

## THE DUNTLEY AIR WASHER.

A number of devices for purifying the air are now being manufactured, among them the Duntley Air Washer. This machine is the outgrowth of the Vacuum Cleaner idea in which the Duntley Manufacturing Company were pioneers.

This machine is constructed of aluminum, and with proper care will last indefinitely. It has an air displacement of two hundred cubic feet per minute, weighs about 25 pounds, and is easily carried from place to place by the handle provided for that purpose. It is equipped with a funnel, easily adjusted at will by a small thumb screw so that the air can be directed in any direction. Being equipped

The principle of operation of the Duntley Air Washer is nothing more or less than to give the air a bath.

By a suction fan revolving with the speed of 3,000 revolutions per minute, the air is drawn into the air shaft and then into an aluminum tube which reaches below the water level in the glass bowl.

Within this tube is a fan, which the air strikes with great force and rotates with such speed as to force the water up in the aluminum tube and against a shield located at the top. When the water strikes this shield it is thrown off in a sort of fine spray or mist, and as the air makes its exit from the machine through the funnel provided for the purpose, it passes through this spray and is washed and purified as if by a summer thunder shower.

## CHICAGO HEALTH DEPARTMENT TESTS

About a year ago the Health Department of Chicago made a series of very elaborate tests on the ventilation of the cars used on the street railways of the city. A number of different systems were tried out with a view to determining the one best adapted for this particular service, the partial results of which are published herewith.

The method of making these tests was as follows:

The exhaust air was measured by placing an anemometer in each of the exhaust windows, and taking the velocity of the air motion. This multiplied by the area of the opening gave the amount of air exhausted through that opening, and the sum of these gave the amount exhausted from the car.

In these cars intakes are placed under the seats, and it is intended that nearly all the air should be taken in through them, where it will pass over the heating coils before entering the car. The air entering by these intakes was measured in the same manner as the exhaust. The difference between the intake and the exhaust shows the amount of air leakage which entered through windows, doors, and cracks.

FINAL OFFICIAL TESTS ON CAR VENTILATORS—CHICAGO HEALTH DEPARTMENT

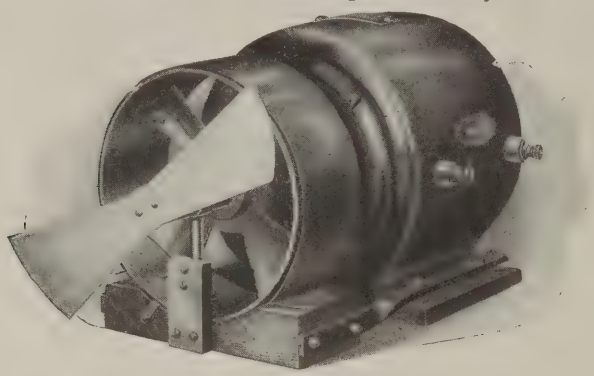
| Date | Name | Line | Type of Car | Number | Wind | Direction of Car | Cu. Ft. Entering per Hr. (Inside of Car) | Cu. Ft. Exhaust per Hr. (Inside of Car) | Front Vestibule Cu. Ft. Hr. | | Rear Vestibule Cu. Ft. Hr. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | In | Out | In | Out |
| Mar. 17 | Automatic | Cottage Grove | P. A. Y. E. | 5318 | N. W. | North | 58,597 | 46,354 | 2,398 | 10,922 | 2131 | 5008 |
| | | | | | | South | | 62,870 | | | | |
| | | | | | | Loop | 25,469 | 33,673 | 2,664 | 9,056 | 6926 | 6127 |
| | | | | | | Standing S. E. | 26,026 | 26,373 | 1,598 | 4,795 | | 8285 |
| Apr. 16 | Cooke | Madison St. | P. A. Y. E. | 102 | N. E. | East | 23,040 | 33,313 | | 1,957 | | 1734 |
| | | | | | | West | 26,873 | 34,445 | | 1,901 | | 1692 |
| | | | | | | North | 32,081 | 32,016 | | 1,376 | | 1924 |
| | | | | | | South | 24,161 | 35,438 | | 1,733 | | 1651 |
| | | | | | | Standing N. S. | 15,082 | 33,893 | | 2,059 | | 1849 |
| May 4 | Garland | Cottage Grove | P. A. Y. E. | 5320 | North | South | 19,076 | 31,121 | | 13,258 | | 6575 |
| | | | | | | North | 29,409 | 44,032 | | 12,935 | | 8408 |
| | | | | | | Loop | 16,428 | 24,734 | | 3,018 | | 4312 |
| | | | | | | Standing S. E. | 7,132* 8,969† | 13,046 | 1,078 | 3,449 | | 5260 |
| May 5 | Min DeLin | | P. A. Y. E. | 5237 | S. W. | South | 26,567 | 34,674 | 934 | 3,703 | 998 | 3881 |
| | | | | | | North | 27,386 | 33,693 | 1,092 | 4,234 | 1248 | 4204 |
| | | | | | | Loop | 26,145 | 33,203 | 1,123 | 4,410 | 2186 | 4098 |

* Intakes } Openings
† Exhaust }

## VOHR OZONIZER.

Purification of air through the agency of ozone is one of the most recent developments in the ventilation field. Ozone is literally concentrated oxygen. Oxygen is the life-sustaining part of air. Therefore, whatever fortifies oxygen in the air increases its value.

It is claimed that ozone as produced by the Vohr



The Vohr Ozonizer.

Ozonizer will give a "mountain air" freshness to the stuffiest room. If so, there is certainly a field for its use in sleeping cars, which are notoriously stuffy in the warm season and in warm climates.

The Vohr Ozonizer consists of a small electrically driven fan rotating inside of a glass ring 6 inches in diameter and 2½ inches wide. The fan forms one electrode and the metal ring outside the glass forms the other. Between these two is a pressure of 9,000 volts, which causes a violet brush discharge acting on the air drawn through by the fan and producing ozone, or rather, ozonized air. Another fan operating on the same axis is placed in front of the machine to increase the volume of air passing through the machine.

The electrical features of the machine are a transformer to step up the current to the necessary high voltage, a small electric motor to drive the fan, and in cases where the machine is operating on a direct current circuit a rotary converter for producing alternating current necessary in the ozonizer. The whole machine is very compact and occupies only about 2 cubic feet of space. It is claimed that one of these machines will purify the air on an ordinary sleeping car at a current consumption not greater than that of the 16-candle-power lamp. In addition to its use as an air purifier in cars, the Standard Electric Utilities Company, which manufactures this machine, claims that a special type of machine producing concentrated ozone can be used in disinfecting cars at terminals. All that is necessary in this case to disinfect a car would be to start the machine going and close the doors.

Up to date this machine has not been constructed to operate on less than 110 volt circuits, but the company is experimenting with lower voltages, the necessary change being simply a different ratio transformer.

## EN ROUTE CAR CLEANERS.

So recent has been the development of the vacuum or suction cleaner that it is only just beginning to be applied to the cleaning of railway cars. Yet there is no field of usefulness in which it will be more welcome. Anything which will relieve the traveling public of the dirt and dust they have had to endure will be acclaimed with shouts of joy both by the weary traveller and by the passenger departments which have had to apologize for the state of affairs which has existed.

There are a number of cleaners on the market today well adapted to use on railway cars. Some of the leading types are described below. The essential principle of all of them is the same, namely the creation of a low pressure, or vacuum chamber into which the dust and dirt is drawn through various openings—some with brushes for jarring the dirt loose from fabrics, and others with simple metallic openings for drawing in dust and foreign matter. These are usually placed on the ends of long flexible tubes so that the machine can be made to operate over a considerable area.

All these machines are operated by electric motors and for that reason can only be operated in trains equipped with electric lights. This is no serious drawback. Nearly every first class train in the United States today is electric lighted throughout. The incidental advantages in cleaning and ventilation made possible by this electrical equipment are just beginning to be realized. They will form an additional argument for hastening the installation of this equipment on cars not yet supplied with it.

## THE FEDERAL VACUUM CLEANER.

Federal Electric Company have completed a cylindrical tank model vacuum cleaner, which is especially adapted for use on railway coaches on account of its compactness and the ease with which it can be moved through narrow openings. In appearance the machine is very similar to a great many others made in the cylindrical form, except that there is a noticeable lack of projections to catch on the clothing or mar the woodwork.

Federal Vacuum Cleaner.

The machine is very light, weighing only 60 pounds without hose and tools. It is 13 inches in diameter and 35 inches high over all.

The two side handles permit the machine to be carried readily for any distance. The operator, when using the machine, can move the machine about the room with one hand by the handle on the cover, as it is mounted on 3 ball-bearing casters.

The most noticeable feature of this vacuum cleaner is that it is absolutely noiseless. In a perfectly quite room it makes less noise than an ordinary electric fan. This is due to the use of a rotary pump which is connected directly to the 1/5 H. P. Holtzer-Cabot motor. There are no gears to rattle, and the rotary motion does not produce any up and down vibration.

A portable vacuum cleaner of the truck type is made by the Keller Mfg. Co., of Philadelphia. The vacuum in this machine is induced by means of a rotary pump connected by a Morse or Reynolds silent chain drive to a 1½ H. P. motor.

# Car Ventilation With the Jandus Gyrofan

BERNARD A. STOWE

The ventilation of Railway Cars by means other than those afforded by open windows, doors and small windows above the half deck received attention as early as 1890. At that time efforts were made to actuate paddle fans supported from the roof of the coach through the medium of wind driven devices resembling cup anemometers which were supported on the roof of the car and the power transmitted by means of vertical shafts to the fans below. The operation depended upon the relation of the train or car so equipped to the surrounding envelope of air, and it is obvious that the effectiveness of such devices varied inversely as the need.

The advent of Electric Train Lighting Systems easily lead the way to the use of Electric Motor Fans, for accomplishing in a way, the ventilation of coaches independent of their movement.

At the outset and for many years, the type of fan motor in common use and designated as a "desk and bracket" fan was accepted for this service. As this branch of the business increased, however, fan manufacturers whose product had found favor in this particular field, soon recognized that car ventilation was in itself an Art worthy of development.

Fans for General Service Cars, Steel equipment, Standard Diners, Pullman, Parlor and Private Cars are subjects for special study and the question of the type of fan best suited to the conditions is often debatable. Oscillating fans have been utilized in a few instances, the pricipal objections to them being their a rather complex mechanism and difficult maintenance.

Fig. 2. Chandelier Gyrofan.

Oscillating mechanisms, however, have been developed which are positive, simple, durable and are thoroughly practicable.

The prevailing practice of locating bracket fans, at the ends of the main body of the car was ignored by a prominent western railroad system when its electrical engineers equipped a number of standard diners of the Jandus Gyrofan. These gyrating fans are supported from the upper car deck. The proximity of the side ventilators and the relation of the Gyrofans thereto insures an intake of fresh air, which, by virtue of the rotation of the Gyrofan fixture is widely distributed throughout the car.

The latest development along this line is the Jandus Twin Oscillator, illustrated herewith. A frame or body portion is secured to the ceiling or upper deck, cushioned and insulated therefrom, the latter qualification being specially desirable on all steel equipment. Two motors, pivotally mounted on crescent shaped yokes adjustably secured to the main frame, the planes of which are vertical and lie parallel to the longitudinal axis of the car, actuate 12-in. propellors

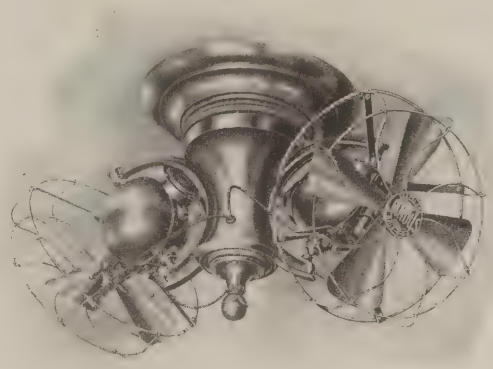


Fig. 1. The Jandus Bracket Gyrofan.

at their outer ends and simple reduction gearing at their inner ends.

This reduction gear belongs to a class of gearing known as "Epicyclic" and by virtue of its peculiar motion, a reduction factor of 126 is obtained by means of one annular and one spur gear. Both gears are of steel, of good size and face. The slow moving element of this gear is provided with an arm which co-operates with a groove or guide on the inner face of the crescent yoke whereby a to and fro or oscillating movement is given to the motor. The Crescent yokes are adjusted to direct the air blast from the propellors more or less downward and by proper location of the fixtures, the entire car may be effectively ventilated.

This arrangement may be characterized as one having a localized intake and a distributed efflux. Moreover, the fans operate in clear space, the incoming air currents not being deflected by such conditions as obtain with bracket fans located at the ends of the car. The Twin Oscillator is available for all voltages and susceptible to any finish. It is arranged for remote control and its operation therefore subject only to the proper car officials.

Exhaust fans are being used extensively in dining car kitchens both vertical flue and horizontal types. Buffet cars and smoking compartments have recently been equipped with 9-in. exhausters for removing smoke and foul air.

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The Safety Car Heating and Lighting Company has recently installed axle lighting equipments on 3 dining cars of the San Pedro, Los Angeles, and Salt Lake Ry. Three steel dynamo-baggage cars equipped with Curtis turbines and 25 K. W. General Electric generators have also been purchased by the same company for use in the fast train service.

# The Electrification of Steam Railways

## Abstract of a Paper Read at the Joint Meeting of the I. E. E. and A. S. M. E. London, July 27-30

By GEO. WESTINGHOUSE

In 25 years the investment in electrical apparatus has grown from practically nothing to over two thousand million dollars. Large sums have already been spent in the electrification of portions of standard steam railways in England, continental Europe and America, and there is now available a fund of information of inestimable value to guide those charged with the selection of an electrical system for railway operations.

Believing, as I do, that the increased capacity of a railway and its stations, the economies of operation and other advantages, will gradually bring about systematic electrification of steam railroads, my wish is that the progress may not be hampered by mistakes which experience, judgment and foresight should enable us to avoid.

I feel that the time is ripe for the selection of standard electrical equipment, which will prevent the extension of the existing diversified systems. The great difficulty in the electrification of standard ralways is no longer the engineering problem of developing a locomotive and an electrical system which will operate trains, but it is a broad question of financial and general policy of far-reaching scope, considering the future electrification of railways in general as distinguished from isolated cases of limited extent, and requiring a combination of the highest engineering and commercial skill.

In 1878 there were in the United States eleven different gauges of railroad tracks. To-day there is practically but one. So far as steam railway operation is concerned there is no obstacle to the interchange of traffic except in the size of cars in certain countries where the cost of changing tunnels and bridges would be prohibitive.

**Requirements for Interchange of Traffic.**

I feel certain you will agree that to insure interchange of traffic, the fundamental requirements, so far as operation by steam is concerned, with full regard for safety, speed and comfort, are very few in number and are covered by the following:

a. A standard gauge of track.

b. A standard or interchangeable type of coupling for vehicles.

c. A uniform interchangeable type of brake apparatus.

d. Interchangeable heating apparatus.

e. A uniform system of train signals.

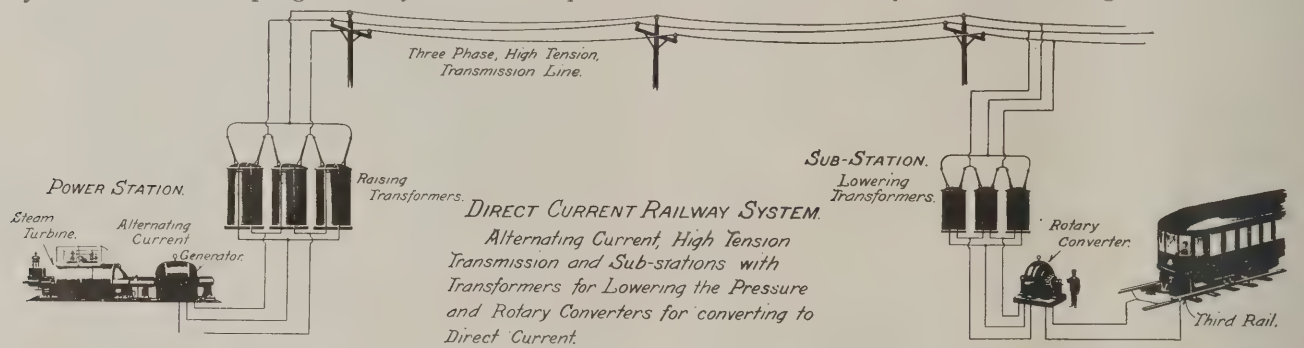

Three Phase, High Tension, Transmission Line.
Power Station.
Steam Turbine.
Alternating Current Generator.
Raising Transformers.
Direct Current Railway System.
Alternating Current, High Tension Transmission and Sub-stations with Transformers for Lowering the Pressure and Rotary Converters for converting to Direct Current.
Sub-Station.
Lowering Transformers.
Rotary Converter.
Third Rail.

Fig. 1. Direct Current with 3-Phase Transmission.

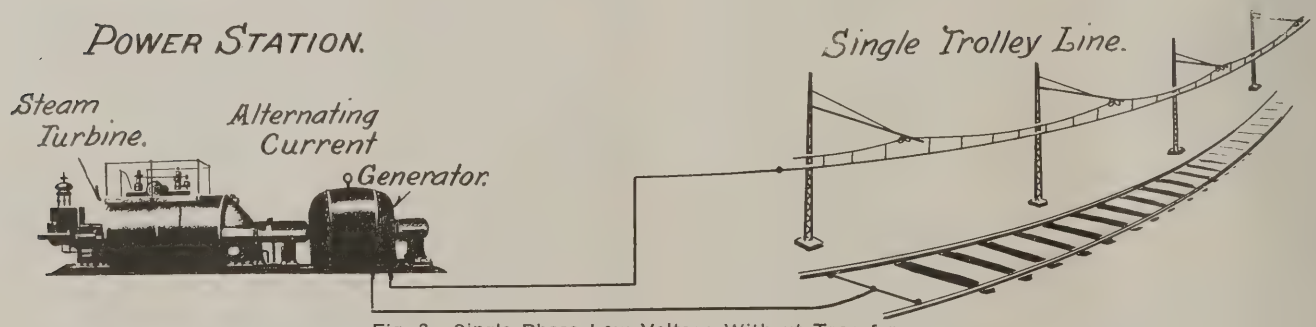



Fig. 2. Single Phase Low Voltage Without Transformers.

The additional fundamental requirements for electrically operated railways are:

f. A supply of electricity of uniform quality as to voltage and periodicity.

g. Conductors to convey this electricity so uniformly located with reference to the rails that, without change of any kind, an electrically fitted locomotive or car of any company can collect its supply of current when upon the lines of other companies.

h. Uniform apparatus for control of electric supply whereby two or more electrically fitted locomotives or cars from different lines can be operated together from one locomotive or car.

There are certain limitations to the continuous or direct system of electrical transmission, and I long ago became convinced that the extended distribution of electricity for industrial purposes could be secured only by the generation of alternating currents of high voltage and their conversion by static transformers into currents of various volt-

ages. I therefore entered actively into the alternating system which is now almost universally adopted as ideal.

In 1892 two single-phase motors of about ten horsepower were built by the Westinghouse company to determine the possibilities of using alternating current for traction work. These motors were designed for 2,000 alternations per minute and about 200 volts. There was a transformer on the car on which there were several taps and the voltage was varied by means of single-pole switches. It was considered at that time that the system would be ideal for locomotive work, but as there were no such projects in view no large motors of this type were built.

**Electrical Systems for Railways.**

As soon as these qualities of the alternating current had been demonstrated, active minds were directed toward the development of apparatus to meet conditions constantly presenting themselves, among the most important problems being the electrification of railways. In the twenty years that

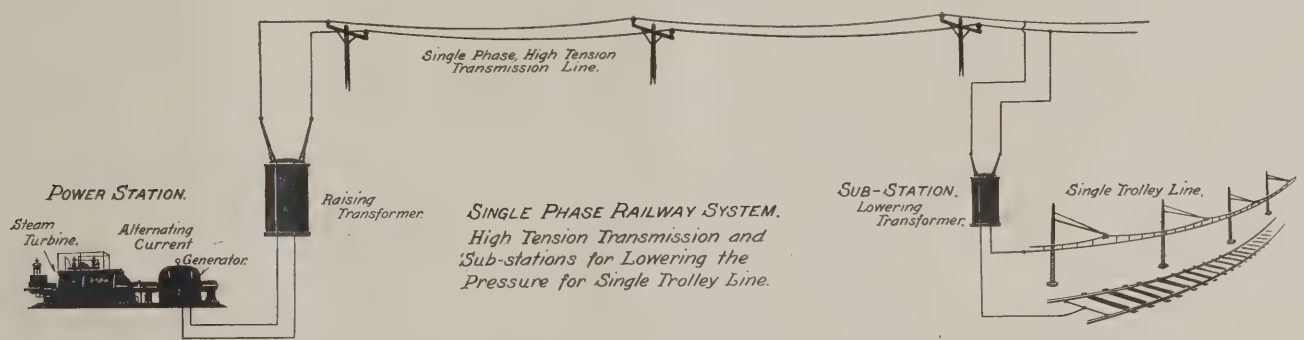



Fig. 3. Single Phase High Tension Transmission.

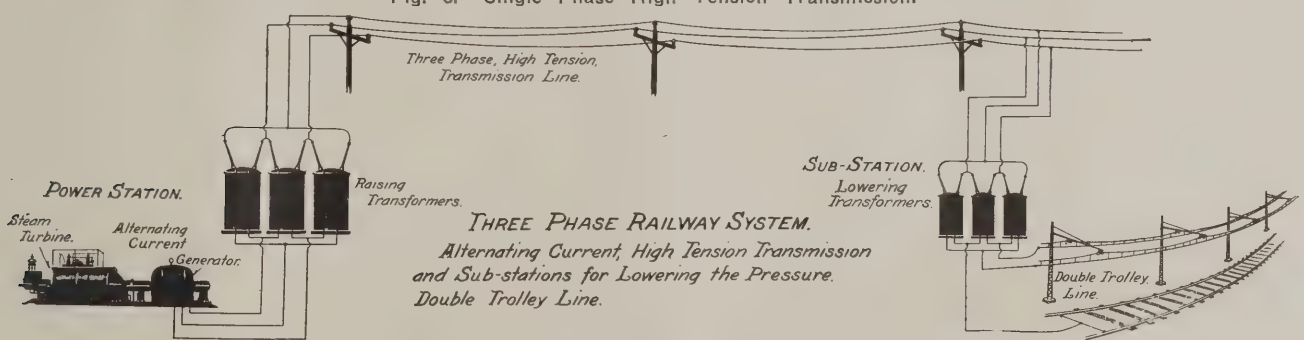



Fig. 4. Three Phase High Tension Transmission.

have elapsed, three important electrical systems for the operation of railways have been put into practical operation, all using alternating current in whole, or in part. These systems are:

a. The continuous or direct-current system, usually spoken of as the "third-rail" system, which employs alternating current for transmitting power when the distance is considerable.

b. The three-phase alternating-current system with two overhead trolley wires.

c. The single-phase, alternating-current high-tension system with a single overhead trolley wire.

A good example of the use of the third system is the installation of the N. Y., N. H. & H. Ry., where the motors have controlling apparatus which is arranged so as to utilize single-phase current from an overhead trolley wire at 11,000 volts, and also to be operated by the current from the 650-volt, third-rail system.

**Railway Motors.**

Essential requisites in a railway motor are that it shall start its load and quickly accelerate it to the required speed, and that it shall operate continuously at any desired speed, or speeds. Railway conditions make desirable speeds varying from the slowest to the highest schedule speeds for regular operation, both for the movement of freight and passengers, and for making up time.

The steam locomotive, which is limited in power by its boiler capacity, is capable of continuous operation at any speed up to the maximum, but the maximum speed in a case depends both upon the length of the train and the grade of the track. It automatically slows down when ascending a grade, so that the actual horsepower developed does not vary greatly at different speeds. The limitation of the capacity of the electric locomotive is not the power available, as is the case with the steam locomotive, but in the capacity of the motors, and is usually fixed by the heating of their coils. An electric locomotive may safely develop for a short time an output which far exceeds its normal continuous capacity. The power and speed characteristics of electric locomotives therefore differ from those of steam locomotives.

Each of the three types of motors has its advantages and drawbacks. The direct current series motor adjusts its speed with the load. With a given load the speed is definite and is dependent upon the voltage supplied by the motor, which cannot readily be varied. As the system of current supplied involves a fixed voltage the result is that in emergencies no speeds much above the maximum determined in the construction of the motor can be obtained.

The three-phase motor runs at approximately the same speed for all loads. Therefore, it can run no faster on the level that it can climb a grade. These motors may be arranged for two or more speeds, but this involves some complications in windings and connections. In this motor, as in the direct current motors, lower speed can be obtained by the introduction of resistances, which greatly increase the losses and lower the efficiency.

The speed of the single-phase motor varies with the load, and also with the pressure applied to the motor. Its advantage over the direct current motor is that its pressure can be varied to any desired degree of refinement by means of auxiliary connection with the transformer. On account of this fact a wide range of speed adjustments can be secured which is impossible in other systems.

Locomotives equipped with each of the three types of motors have been in successful operation and have demonstrated their usefulness and reliability in railway service. A controlling apparatus has been developed on locomotives which insures reliable operation.

**Transmission of Power to Locomotive.**

The controlling factor in the cost of electrification in nearly all cases is the system for transmitting power from the power house to the locomotive, and not the locomotive itself. The choice between the several systems must, therefore, be based on a comparison of the complete systems. The differences between the methods of transmitting power are of far greater importance than the differences between power houses or between locomotives. The current for all systems is generated in usual practice as high-tension alternating current, for the reason that electric energy can be most economically transmitted by high-tension alternating current even though it is in some cases converted into direct current.

**The Direct-Current System.**

For the direct-current locomotive the apparatus which intervenes between the alternating-current generator and the locomotive consists of a number of links or elements through which the electric energy must pass, one after the other. These consist of:

a. Raising transformers in groups of three.
b. A transmission line of three wires, sub-stations, which require attendance, containing
c. Transformers in groups of three, and
d. Rotary converters for receiving the alternating current and delivering direct current.
e. A third-rail contact .conductor, which for heavy work must often be supplemented by copper feeders.
f. The track return circuit, which must be provided with heavy bonds, and in certain cases supplemented by feeders and so-called negative boosters.

**The Three-Phase-System.**

For the three-phase locomotive the respective links between the generator and the locomotives are:

a. Raising transformers in groups of three.
b. Transmission line of three wires.
c. Substation transformers in groups of three.
d. Two overhead wires as the contact system.
e. A track return which usually requires nothing but inexpensive bonding.

The two overhead trolley wires require a double system of overhead construction, as the wires must be kept separate and well insulated from one another; the two must be maintained at equal height above the track and at switches and cross-overs the construction is complicated.

**The Single-Phase System.**

For single-phase locomotives there is:

a. A raising transformer.
b. A transmission line of two wires and substations widely spaced, each containing
c. A lowering transformer, which supplies
d. A single trolley wire.
e. A track return, usually requiring nothing but inexpensive bonding.

In certain cases where the distance from the power station is not more than fifteen or twenty miles, the single-phase trolley can be supplied directly from the power house, so that only one single element, i. e., the trolley wire, intervenes between the generators and the locomotives.

The three types of railway motors, and the three respective systems for conveying power from the generating station to the locomotives, have all successfully demonstrated their ability to operate railway trains. It is not my purpose to urge the adoption of a particular system, but rather to point out some of the well-known characteristics of these systems which have a bearing upon their limitations and their general adaptability to railway conditions, and to urge the great gain which will result from a single and universal system.

**Requisites for a Universal Electric System.**

In selecting a proper electrical system for railway operation, it will probably be generally conceded that the following elements are of prime importance:

a. The electric locomotives should be capable of performing the same kinds of service which the steam locomotives now perform. This will be most readily secured by electric locomotives which can practically duplicate the steam locomotives in speed and power characteristics.

b. The electric locomotive should be capable of exceeding the steam locomotive in its power capacity. It should be able to handle heavier trains and loads, to operate at higher speeds, and in general to exceed the ordinary limits of the steam locomotive in these regards. The readiness with which several electric locomotives can be operated as a single unit enables any amount of power to be applied to a train.

c. The electric system should adapt itself to requirements beyond the ordinary limitations of the steam locomotive in small as well as large things. It should be adapted for use on branch lines, and for light passenger and freight service similar to that so profitably conducted by interurban electric roads, which in many cases run parallel to steam roads, not only taking away the traffic of the steam roads, but building up a new and highly profitable traffic, both in passenger and express service.

d. A universal electrical system requires that power should be transmitted economically over long distances and supplied to the contact conductor. The system should utilize the most highly perfected apparatus for the electric transmission of energy and its transformation into suitable pressures for use.

e. The contact conductor in an ideal system should be economical to construct, both for the heaviest locomotives where the traffic is dense, and for light service on branch lines. It should impose minimum inconvenience to track maintenance; should give minimum probability of disarranging in case of disrailment, or in case of snow and sleet, and should in general be so placed and constructed

as to give a maximum assurance of continuity of service.

**The Future of Electrification of Railways.**

The complete electrification of a railway will necessitate a re-arrangement of ideas and practices in regard to operation. Coaling and watering places will not be needed; passenger trains will be differently composed, some classes being of less weight; and they will operate more frequently, thus promoting travel; other trains will be heavier than at present, or will operate at high speed; and branch lines, by the use of electrically fitted cars, can be given a through service not now enjoyed.

The movement of freight will undergo great changes, due to the fact that electric locomotives can be constructed with great excess capacity, enabling them to move longer trains at scheduled speed on rising gradients.

The railway companies can combine upon some co-operative plan for generating electricity, thereby effecting large savings in capital expenditures; and can utilize their own rights of way for the transmission of the current, not only for the operation of trains but for many other useful purposes.

Notwithstanding the fact that great strides have already been made in cheapening the cost of generating electricity by steam engines, I foresee, from the progress made in the development of gas and of engine power, a still further reduction in cost which will accelerate the work of electrifying existing railways.

One important aspect of this great question will engage the thoughtful consideration of every government, namely, the military necessity for uniform railway equipment in time of war.

There will be serious difficulties to surmount in the selection of a general system. There naturally will be arguments in favor of one or another of the systems now in use and the inclination of those who have adopted a particular system to advocate its general use. There will be enthusiastic inventors, and there will be many advocates of the common view, namely, that there is room for several systems and that each system will best meet the requirements of a particular case. There will be those who give undue weight to some feature of motor or of locomotive, instead of giving a broad motor or of locomotive, instead of giving a road consideration to the whole system, and recognizing that, in the general problem of railways electrification, facility and economy in transmitting power from the power house to the locomotive, are of controlling importance.

Were now there only one system to be considered, there would be a concentration of the energy of thousands on the perfecting and simplifying of the apparatus for that system, to the advantage of railway companies and of manufacturers. In conclusion, I can only repeat, and earnestly recommend to the serious consideration of railway engineers and those in authority, the pressing need of determining the system which admits of the largest extension of railway electrification and of a prompt selection of those standards of electrification which will render possible a complete interchange of traffic in order to save expense in the future and to avoid difficulties and delays certain to arise unless some common understanding is arrived at very shortly.

## ELECTRIFICATION OF CINCINNATI TERMINALS.

The Pennsylvania Railroad Company have made plans to spend in the neighborhood of a million dollars in the electrification of its Cincinnati terminals and when this is complete in establishing a through service of suburban train between Cincinnati and Lebanon and way points. They will also build a connecting link with the Chicago division at Kennedy and a line will be built from Clare by which means all trains will be diverted to the electric route and brought into Cincinnati at the Court Street terminals. In order to do away with the smoke nuisance the company will enlarge its yards and all switching will be done with electric engines.

## ELECTRIC RAILWAYS.

In a paper read before the Central Club, at Buffalo, on May 13, Mr. Frederick Darlington stated that estimates recently prepared for the electrification of about 100 miles of single-track railroad, with about 25 miles of side tracks and with heavy grades to be climbed and very heavy and frequent trains to be handled, show the total cost of direct-current transmission and distribution apparatus, including sub-stations, to be $2,381,000, and for single-phase alternating current with transformer stations $1,011,000. This was figured for 1,500 volts on a third rail for direct current and 11,000 volts on an overhead trolley for single-phase current. The difference in cost of the two distribution systems is $1,370,000. However, the single-phase locomotives for the same railroad would be more costly than direct-current locomotives by about $374,500, but this amount is only about one-quarter of the difference in the cost of the transmission and distribution appliances. In discussing the paper, Mr. L. R. Pomeroy said that the advocates of electric traction have been dwelling on only a small portion of the various elements involved in the cost of transportation and that the effectiveness of engineering recommendations is somewhat diminished by the fact that the advice given is not always disinterested. He remarked that the electrical achievements thus far made, while mainly confined to passenger traffic, have shed little light, except in special cases, on the larger problem of freight train operation.

## MONO-RAIL ROAD FOR ALASKA.

According to reports attributed to Mr. Louis Brennan, he has granted a license to Major John E. Bellaine, one of the original promoters of the Alaska Central Railroad, for the extension of that railway on the Brennan mono-rail system for a distance of about 100 miles. The object of the extension is to connect the line with rich coal fields situated about 185 miles north of Seward, which are said to contain seams of bituminous and anthracite coal up to 38 ft. in thickness. It is possible that the 100 miles may be increased to 1,000 miles, but in the meantime Major Bellaine has undertaken to finish the present extension by December, 1912. He estimates that the cost of rails iwll be $1,870 a mile, sleepers $280, labor, equipment and other expenses $2,750, or about $5,000 a mile. He proposes to start working with two cars, each capable of carrying 50 or 60 passengers, and of making two journeys a day at 20 miles an hour. He estimates the receipts will amount to a total of $200,000 a year.

# Improvement of Electric Lighting in Old Cars

C. R. GILMAN

*Interior decoration shows to the best advantage in a subdued light, and as most of the lamps are high up in the car, it requires rather an opaque reflector of proper design to subdue the light on the ceiling and side walls, and bring the larger amount of it down to the reading line. Colored shades if just right, add very much to the appearance, but nothing defeats your scheme of lighting more than the wrong color in shades, and unless one has had considerable experience in color combinations, it is safe practice to keep away from them.

Looking over the subject as I have outlined it, let us take up and examine the observation end of a Library Buffet car. You will note this is a floor plan and shows 32 16-c.p. lamps in this room. All lamps stand at an angle of 45 degrees and are without shades of any kind. The size of this room is 9 ft. 3 ins. by 21 ft., 193 sq. ft. Without the use of instruments we can arbitrarily judge this scheme of lighting by saying 30 per cent can be cut out, by hiding the light from the eyes, while 20 per cent can be saved by the use of efficient reflectors. Therefore, reduce the current consumption 50 per cent and apply efficient reflectors. We must not be too hasty in this matter, however, as other conditions may affect the removal of half of the lamps and a theoretical analysis of the problem in illumination becomes necessary. Accordingly, we will apply some of the rules for illumination that have been deduced by prominent illuminating engineers of the country. It has been computed that by multiplying the area of the room by the candle feet required and this again by a certain constant depending upon the type of lamp and reflector used, that the total current consumption required can be readily calculated. These rules and tables of constants most of you have, but, if not, you can procure them for the asking from lamp and shade manufacturers. In applying these rules successfully, one should take into consideration the details that affect the result, all of which are pointed out in the bulletins previously referred to. Taking a specific example in car number 1, we find we have 193 sq. ft. floor area. Multiply this by 2.5 candle feet (decided on) and again multiply by the constant, .7 for 3-1/10 carbon lamps, opal dome reflectors, dark walls and light ceilings, and we have 337.7 watts required. Contrast this with the watts used with the original equipment (1600) and it is hard to believe. Here is where a portable photometer is of advantage, without which results in this kind of work must largely be guessed at.

Fig. 1. Buffet-Library Car Before Change, With Bare Lamps.

When this car was received at the shop for repairs the number of lamps was reduced to 16 8-c.p. 26-watt carbon lamps with Alba reflector shades having a total lamp consumption of 416 watts. This is a little higher than the theoretical calculation above would indicate. Upon making a photometric test of this car after the installation of the new fixtures it was found that an illumination of 2.18 candle feet was obtained instead of the 2.5 candle feet as originally assumed.

These observations were taken in a horizontal plane 30 ins. above the floor. This method of test was decided upon in preference to an inclined plane test inasmuch as the chairs are movable and passengers set them at any position they choose. However, 2.18 candle feet on flat plane 30 ins.

*Continued from the July Issue.

cided was correct. This remarkable result, with above floor gives good reading light in any position. Contrast this again with test made before change 4.26 candle foot watts per sq. ft. to 8.28, and we see that while the candle foot illumination is less than calculated, it is still nearly what we de-

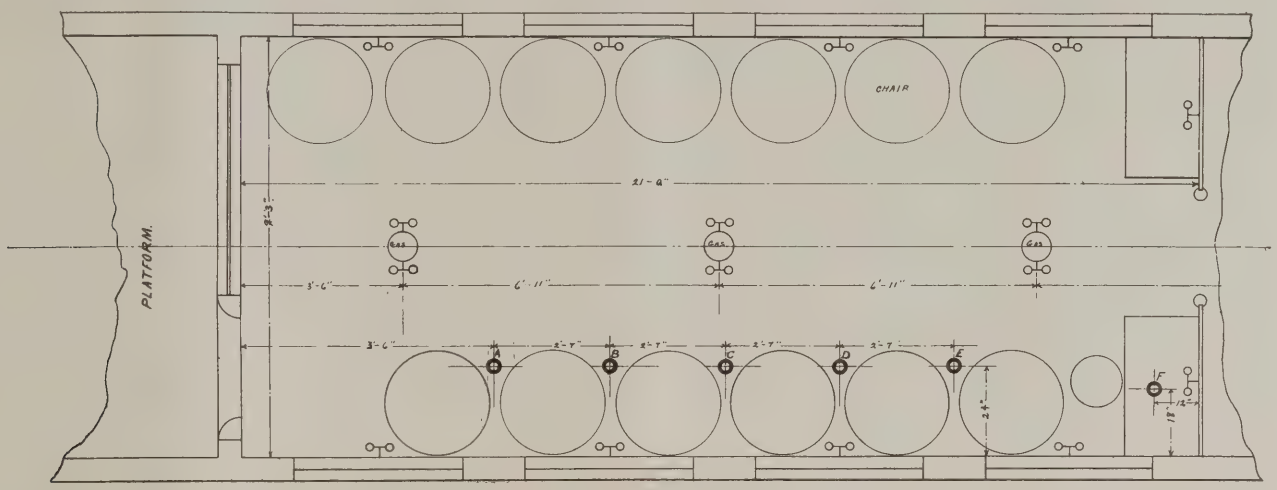



Fig. 2. Plan of Car. Light Circles Show Position of Lamps. Heavy Circles Show Test Stations.

half the number of fixtures, and less than one-third the watts previously used, shows what can be done by the use of efficient reflector shades. The psychological effect of the lighting was also improved at least 50 per cent. Previously the glare of the bare lamps was very trying on the eyes, and there was so much light in the upper part of the car that the

The total number of watts consumed in this car was 936, representing a unit consumption of 2.17 watts per sq. ft. This was not so bad, but the large number of lamps and the absence of shades of any kind made it a most unpleasant car to sit and read in. Photometric test before the change was made gave 1.9 candle feet, 30 ins. from the floor on flat plane, with 2.17 watts per sq. ft. I first thought of removing the lamps from the lower deck rail, and depending on the center lamps only. There were some objections made to this, although with proper reflectors installed there would have been ample light left in the car. We then thought

Fig. 3. Buffet-Library Car After Change, With Reflectors.

effect of the beautiful wood work and finish was practically lost.

The total cost of making the above change was $37.35. The yearly saving, I estimate as follows:

| | |
|---|---|
| 16 lamps saved on investment equipping car. | $ 3.20 |
| 48 lamps saved during year for renewals.... | 9.60 |
| Current at 11c per 1000 watts..... | 237.68 |
| Total ..... | $250.40 |

of taking away the center lamps. This would have spoiled the appearance somewhat, so we concluded to reduce the number of lamps on each center fixture, apply satin etched Holophane reflector shades and let it go at that. This cut down the number of lamps to 26, and the total watts consumed to 676, giving 1.54 watts per sq. ft. A photometric test of the new installation gave 2.28 average C. F.

The cost of making this change and furnishing new shades was $18.10, and the yearly operating saving was $60.23, not very much, but well worth our attention.

Fig. 4. Parlor Car with Bare Lamps.

The next subject for consideration is a dining car. The floor plan in Fig. 5 shows the lamps and test station, the thin circles indicating lamps and the heavy ones, test stations. There were 25 16 C. P. 110 Volt, 52 Watt Carbon lamps in this dining room, making a total current consumption of 1300 watts. The area of the room is 302 sq. ft., and accordingly the watts per sq. ft. was 4.3, giving an average of 2.1 C. F.

The three light center fixtures were removed and a flat ring holding one lamp and shade was put in their place. This reduced the total number of lamps to 15, 5-10 C. P. 40 watt lamps in the center, and 10-8-C. P. 26 watt carbon lamps over tables, total watts 460. A photometer test of the remodeled installation shows that we now have 2.18 C. F. while the watts per sq. ft. has been reduced to 1.53. I tried 16 C. P. lamps over the tables in place of the 8 C. P., but found them too strong for the center lamps. The long tables showed .5 C. F. more light next the wall than on end next aisle. This is only what could be expected in using the higher power lights over the tables. The cost of this change as computed above in the other cars was $34.20 and the saving per year found to be $176.63.

This car is a good example where a greater saving could have been made by scrapping old fixtures and applying the new box type over the tables and using tungsten lamps. Fig. 8 shows this arrangement. The total watts then would have been 300 and a total saving of over $200.00 per year effected.

The new fixtures, moreover, would have made this car up to date and put it in a higher class of service than it is now considered fit for. This remarkable saving could only be made by using tungsten lamps, but of course we can not go into their use until a 64-volt standard is adopted for head end systems.

This redesign of the lighting equipment of first class cars will relieve to a very large extent the trouble we now have with overloaded axle equipments, and straight storage cars. It will also help our head end systems which are now overtaxing the generating units. As I have said before, I hope this matter will be taken up by all of you and that in the near future we will hear more about it in these columns.

Fig. 5. Same Car Showing Improvement Made with Reflectors.

Fig. 6. Dining Car Before Change.

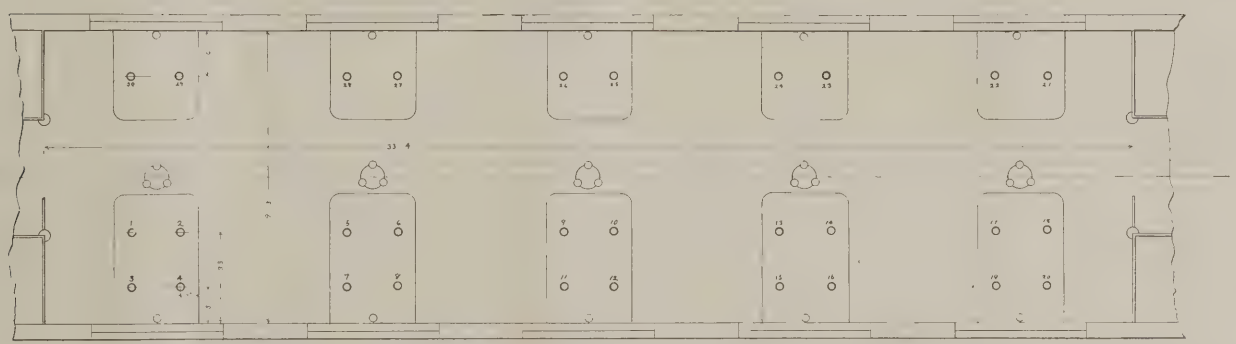


Fig. 7. Plan of Car. Light Circles Show Position of Lamps. Heavy Circles Show Position of Test Stations.

Fig. 8. Showing Improvement Made By Change.

# The New Edison Storage Battery

## A Steel-Cased Battery with Nickel and Iron Elements in a Caustic Electrolyte

The Edison Storage Battery Company, of Orange, N. J., have now placed on the market their new storage battery adapted to the electric lighting of passenger train cars.

At present these cells are made in three sizes, A-4 having four positive and five negative plates, A-6 having six positive and seven negative plates, and A-8 having eight positive and nine negative plates, their rated capacity being respectively 150, 225 and 300 ampere hours. The general construction of the cell is clearly shown in the accompanying engravings, which, supplemented by the following brief description, should suffice to give a clear impression of the mechanical features of the Edison battery.

The active material of the positive plate consists of nickel-hydrate, while in the negative it is iron oxide.

The electrolyte consists of potassium hydrate (21% solution) to which is added a small amount of lithium hydrate. The normal specific gravity of the solution is 1.210, which does not change during the charge or discharge, and the efficiency and capacity of the cell is not affected to any extent when the specific gravity falls as low as 1.160. Below this a temporary effect is noticeable in the output of the cell.

The retaining cans are made of electro-plated steel, welded at the seams by the autogenous method, that is by the application of the oxy-acetylene blowpipe. The walls of the can are corrugated so as to obtain the greatest amount of strength with the minimum weight.

The positive or nickel plate, Fig. 2, is seen to consist of two rows of round rods, or tubes, about the size of an ordinary lead pencil, thirty in number, which are held in a vertical position by a steel support frame. The pencils have flat flanges at the ends (formed by closing in the metal case) by which they are supported and electrical contact is made. The frame is slit at the inner horizontal edges and then folded in such a way as to make individual clamping jaws for each end flange. The clamping is done under a pressure of 50 tons and the resultant plate has great rigidity and strength. The perforated steel tubes in which the nickel active material is loaded, are made of nickel-plated steel of high quality. They are put together with a double-lapped spiral seam in order to give expansion-resisting qualities and as an additional precaution small metal rings are slipped on the outside. Each tube is ¼ inch in diameter by 4⅛ inches long and has eight of these re-inforcing rings. It will seem that the positive plate has been given the theoretically best design to prevent expansion and to overcome trouble from that cause.

Electro-chemically prepared layers of pure nickel are interspersed in the nickel hydrate to increase the conductivity of the active mass, as nickel hydrate, in itself, is a poor conductor.

The negative or iron plate, Fig. 3, contains flat pocket-like sections which are also brought into good electrical contact with a supporting frame at a pressure of 160 tons.

The plates of each group are hung on a connecting rod perpendicular to, but integral with the pole, as shown in Fig. 4. They are held apart by nickel-plated steel washers and held firmly in contact by nuts screwed on both ends. The two outside plates are negative and are insulated from the retaining can by sheets of hard rubber (Fig. 5); hard rubber pieces are also set between the can and the side and bottom edges of the plate and these, together with the hard rubber rods inserted between the plates, maintain correct spacing and insure permanent insulation.

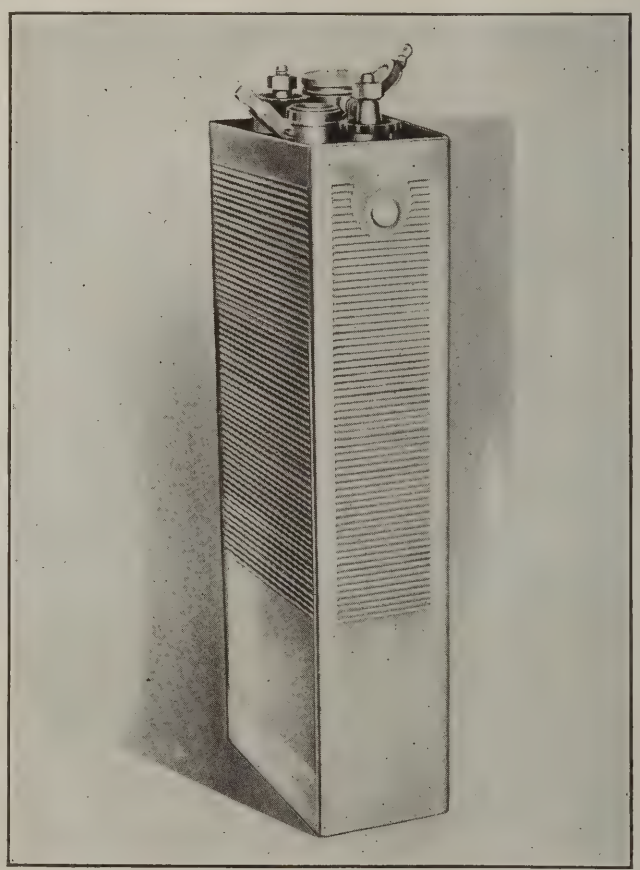


Fig. 1. The Edison Storage Battery.

The cover of the cell, which is welded in place, has four mountings. Two of these are for stuffing boxes through which the positive and negative poles extend; one is the separator, which prevents the loss of the electrolyte while allowing the gas to escape; and the other is an opening for water and the electrolyte. This opening is fitted with a water-tight cap, held in place by a catch. Fastened to the cap is a spring so arranged that the cap will fly open unless properly fastened.

In an assembled battery each individual cell is held securely in place and from contact with adjacent cells, by means of insulators.

An idea of the conditions inside a loaded tube can best be obtained by a microscopic examination. Fig. 7 shows a magnified section of a regularly loaded tube which has been sawed lengthwise.

The vertical founding walls are edges of the perforated-metal containing tube; the dark horizontal lines are layers of nickel flake; while the light colored thicker layers represent the nickel-hydrate. It should be noted that the layers of fine nickel extend practically unbroken, across the tube and

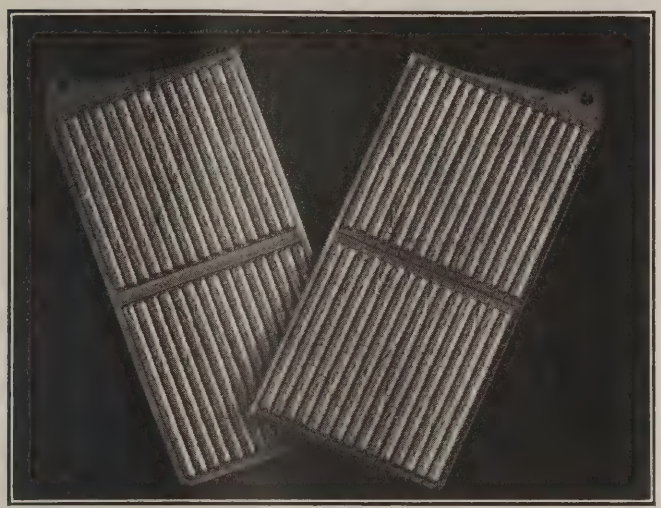


Fig. 2. The Positive Nickel Elements.

make contact with the metal wall at both sides. These metal layers conduct current to or from the nickel hydrate in all parts of the tube very efficiently. There are about 350 layers of each kind of material in a 4¼ inch tube, each layer of nickel hydrate being .01 inch thick; so it will be seen that the current does not have to penetrate very far in the nickel hydrate, one half the layer's thickness being the maximum distance. The perforations of the containing tube, through which the electrolyte reaches the active material, are also shown in Fig. 7.

The principle on which the action of this new battery is based is the oxidation and reduction of

Fig. 3. The Negative Iron Elements.

metals in an electrolyte which does not combine with, and will not dissolve, either the metals or their oxides; and an electrolyte, furthermore, which, although decomposed by the action of the current, is immediately re-formed in equal quantity and therefore, in effect, is a constant element, not changing in density or conductivity.

A battery embodying this basic principle will have features of great value where lightness and durability are desired. For instance, the electrolyte being a constant factor, as explained, is not required in any fixed and large amount as is the case with sulphuric acid in the lead battery; thus the cell may be designed with minimum distancing of plates and with the greatest economy of space that is consistent with safe insulation and good mechanical design. Again, the active materials of the electrodes being insoluble in, and absolutely unaffected by the electrolyte, are not liable to any sort of chemical deterioration by action of the electrolyte, no matter how long continued.

Those who have had experience with lead batteries know what care is required to prevent sulphation, the "white plague" of the lead battery, which is caused by chemical action of the electrolyte on the active materials. They will also appreciate that such a disease-free battery as this is the augury of beneficent revolution in electric train lighting.

It must be noted that all parts of the Edison battery are made of nickel-plated steel, a material in which lightness and durability and mechanical strength are combined, and a material which is not subject to corrosion in an alkaline electrolyte. The

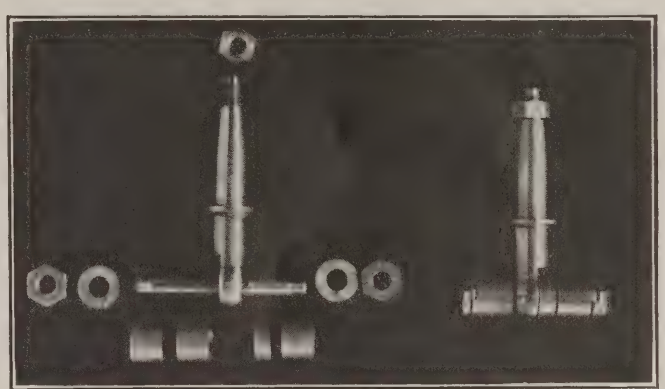


Fig. 4. Rod Plate Connector.

freedom from corrosive action allows the assembling of the cells in all all-steel tank or crate of the same outside dimensions as is now employed for the lead battery. In place of two cells of lead, whose combined weight aggregates 350 pounds, it is possible to place five cells of the Edison, whose total weight is 150 pounds. Thus it can readily be seen that although it is necessary to employ fifty cells of the Edison for the same equivalent voltage as thirty-two cells of lead, the total space occupied will be considerably less. The total weight of thirty-two cells of standard 300 ampere hour lead battery, is 5,500 pounds, whereas fifty cells of 300 ampere hour Edison weigh only 1,500 pounds, thus showing a saving in weight of two tons per car equipment.

If this great saving in weight is figured on the ton mileage basis, a method of figuring employed in determining the cost of hauling high class trains, a great saving in cost will be demonstrated. For instance, take a run of 500 miles at 3 mills per ton mile. The lead battery weighing 2¾ tons would cost to transport one mile .825 cents; to transport 500 miles, it would cost 500 times .825 cents, or $4.12. The Edison battery weighing ¾ of a ton would cost, at the same rate, per ton mile, .225 cents per mile and for 500 miles it would cost 500 time .225, or $1.12. This saving in cost of trans-

portation, spread over a period of three years, would pay for the difference in the initial cost.

Following are the cell dimensions in inches and weight in pounds:

| | A-4 150 A.H. | A-6 225 A.H. | A-8 300 A.H. |
|---|---|---|---|
| Width of can (outside) .. | 2 1/16" | 3 3/4" | 4 7/8" |
| Breadth of can (outside).. | 5 1/8" | 5 1/8" | 5 1/8" |
| Height of can (outside.. | 12 3/8" | 12 3/8" | 12 3/8" |
| Height of cell to top of pole (not assembled) .. | 13 1/2" | 13 1/2" | 13 1/2" |
| Weight of complete cell. | 13.5 lbs. | 19.2 lbs. | 25.2 lbs. |

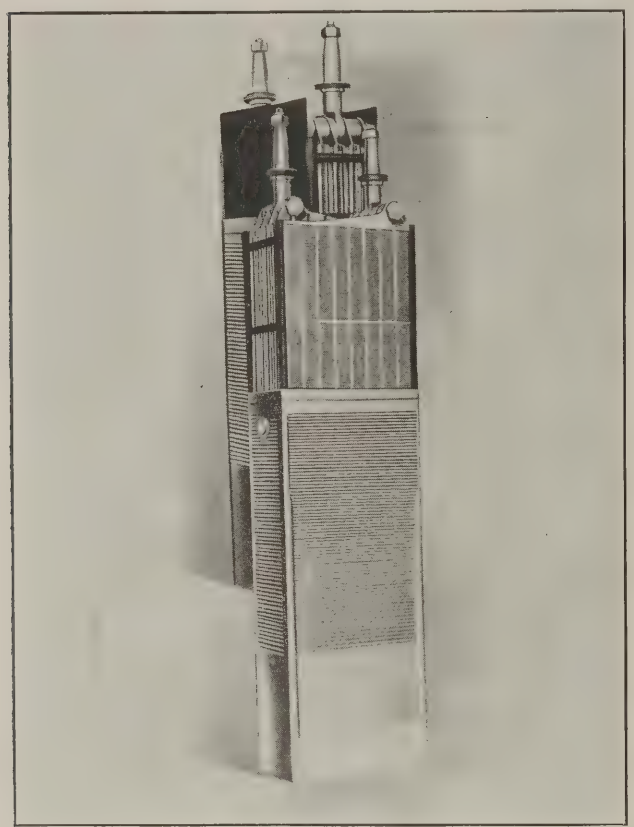


Fig. 5. Showing Insulation of Plates.

In summation, then, the characteristics of the Edison battery which fit it so pre-eminently for electric train lighting service are as follows:

1. The perforated-container construction prevents loss of material by disintegration, doing away with sediment short-circuits and the necessity of cell washing.

2. A steel containing can has very obvious mechanical advantages over a hard-rubber jar or lead

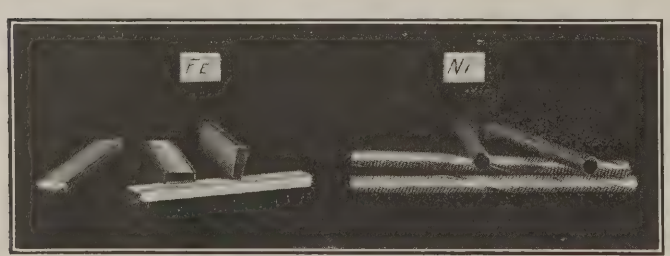



Fig. 6. The Individual Elements.

lining, and the expensive delays and trouble caused by jar breakage in lead batteries are thus eliminated.

3. The steel-and-copper connectors used in connecting cell posts are easily removable, and make it possible to disconnect or replace any cell of a battery in a very short time without the employment of a skilled laborer, such as a "leadburner."

4. The steel-and-nickel construction of the plates makes buckling impossible; even a dead short circuit of the poles will not effect the condition of the plates in the slightest degree.

5. The simplicity of the care required in looking after a large number of batteries, due to the absence of regularly adjusting the electrolyte.

6. The materials used in the cell being exceedingly durable by nature and the construction being very rugged, a cell will stand an almost unlimited amount of vibration and shock without injury.

7. Freedom from "sulphation" or any kind of chemical corrosion eliminates a very insidious source of trouble and depreciation.

8. Lack of corrosive fumes prevents the destruction of the metal work, either of the car or the containing vessel, or any part of the battery equipment.

9. The light weight of the battery in comparison with lead batteries gives it many evident advantages.

10. Freedom from growth or injury of any kind if left in a discharged or charged condition for an indefinite length of time.

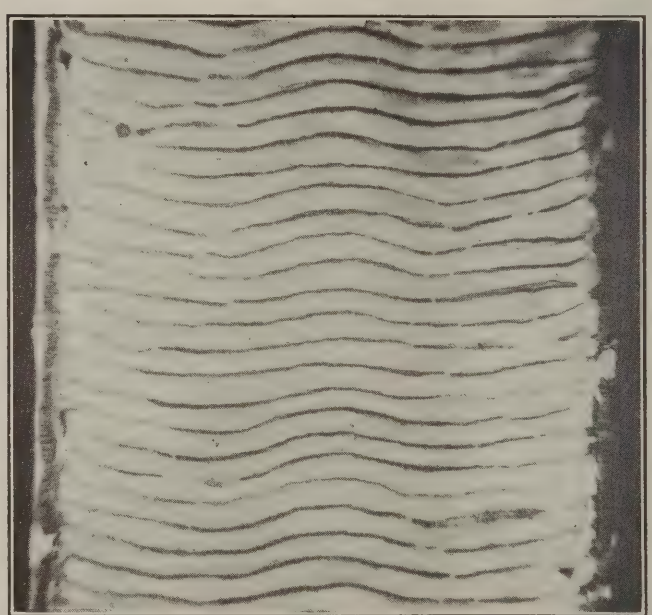


Fig. 7. Cross Section of Nickel Element Magnified 12 Times. Dark Bands Are Nickel. Light Bands are Nickel Hydrate.

## PULLMAN COMPANY TO MAINTAIN CAR LIGHTING.

The Pullman Company has begun an extensive campaign for the work of maintaining the electric lighting equipments of their cars which are in service on the various railroads, with the result that they are fast relieving the railroad electrical department of this work. A fixed compensation per car mile is paid by the company for the maintenance of these equipments.

Pullman sleepers lighting equipments being maintained under these arrangements include all those on the following lines:—

| | |
|---|---|
| Baltimore & Ohio. | Norfolk & Western. |
| Baltimore & Ohio Southern. | Seaboard Air Line. |
| | Atlantic Coast Line. |
| Delaware, Lackawanna & Western. | New York Central & Hudson River. |
| Missouri, Kansas & Texas. | Chicago, Cincinnati, Cleveland & St. Louis. |

| | |
|---|---|
| Lehigh Valley. | Michigan Central. |

Partial maintenance of the sleeper lighting on a number of other roads has also been assumed by the Pullman Co. Among these are:—

| | |
|---|---|
| Wabash. | Pere Marquette. |
| Boston & Maine. | Frisco. |
| Galveston, Houston & San Antonio. | El Paso & Southwestern. |
| | Denver & Rio Grande. |
| Chicago & Alton. | Chicago, Rock Island & Pacific. |
| Illinois Central. | |

## STORAGE BATTERIES ON ALTERNATING-CURRENT SYSTEMS.

A note on a recent British patent of A. M. Taylor (2147, 1909; April 21, 1910). Low-voltage storage-battery units, each of a few cells, of large rating, are installed in a substation on a high-tension, alternating-current distribution system for the purpose of relieving the generating station of the peak loads, and for improving the power-factor of the system. Each set, comprising a battery, a synchronous motor-generator, and a transformer, is connected to the low-tension side of the main transformers. The excitation of one motor-generator is controlled automatically from series and shunt instrument transformers on the outgoing feeders, so that it is overexcited and (running as a motor) takes enough leading current to compensate for the lagging current of the load. Another motor-generator is automatically controlled so as to compensate for the lagging currents on the high-tension side. All the motor-generators are driven from the batteries to supply alternating-current energy for the peak loads. A method of inserting a transformer (fed from a battery unit) into the high-tension feeders to compensate automatically for the reaction or capacity of the transmission line is also described.—London Electrical Engineering, April 28.

The Cutter Electrical and Manufacturing Company, through its Chicago office, recently closed a contract for the circuit breakers for the Chicago & Northwestern Railway Company's terminal power house in Chicago. The equipment, as specified by Pierce, Richardson & Neiler, consulting engineers, is composed of I-T-E motor operated remote control circuit breakers and switches for the protection of the engine, turbine and motor driven generators. This apparatus is so constructed that whether being operated electrically from the control board or manually at the breaker, it cannot be held closed against an overload or reversal of current, and is equipped with direct acting inverse time limit (Dalite) devices throughout.

## LIGHT PRESSURE.

An interesting lecture was recently delivered before the University of Paris by Professor Poynting of the University of Birmingham. Experiments were made showing the existence of momentum of radiation and methods of making quantitative measurements of the values explained. The experimental work and espepecially the quantitative measurements require the highest degree of skill, because of the very small magnitude of the forces. On the earth and in the atmosphere these phenomena are too minute to be detected, but in the interplanetary space, where a perfect vacuum exists, these forces become very large; for instance, it is calculated that the sunlight exerts a force of 70,000 tons upon the earth. This at first seems very large until it is recalled that the gravitation force between the sun and earth is 40 million million times greater. The author pointed out that the forces exerted on the planets by the pressure of impinging radiation must have a very considerable effect, when acting through ages of time. The pressure exerted by radiation from the sun upon a body acts against gravity, and as the size of the body is reduced the ratio of radiation pressure to gravitation increases until a point is reached where the radiation pressure exceeds gravitation when the body is driven out of the solar system entirely.

## DETERIORATION OF STEEL CONDUIT IN CAR LIGHTING SERVICE.

The accompanying illustration is a fair sample of what frequently happens when a steel conduit is placed upon the roof of a car. The specimen shown is a section of a ¾-in. steel conduit, which carried a lateral circuit coming from one of the junction boxes on the car and, being placed on the top of the car roof, was exposed to the action of wind and cinders.

The deterioration of this conduit, as illustrated, is not any ordinary rusting of the steel, but is due more largely to a mechanical cutting effect of the cinders from the engine striking the exposed conduit while the train is traveling at a high speed. It should be noted that practically all of the wear takes place on the sides of the conduit rather than on the

top, while the bottom surface of the conduit is practically intact.

This particular piece of conduit had seen only about three years' service on one of the prominent railroads of the country, but it may be taken as a typical case of wear where this type of construction is employed.

## NORTHWESTERN ELECTRIC STUNTS.

Since June 24th electric lighting service has been in use on trains No. 101 and 102 on the Chicago, Northwestern Railroad between Chicago and Calumet, Mich. This train consists of a mail car, express car, dynamo car, coach and three sleepers, with a parlor car and diner leaving Chicago. A Curtis turbo generator is installed in the dynamo car which also carries a Willard 300-ampere 64-cell battery. The lights are on a 110-volt system.

When the battery is being charged the current flows through a lamp regulation resistance in the baggage car and serves to maintain a constant lamp voltage during the night. No auxiliary batteries are carried, the one in the baggage car being large enough to take care of the whole train. With the exception of the "Soo" and Menominee sleepers, which are switched off before the train reaches Calumet, no provision is made for auxiliary gas lighting. The diner is provided with axle equipment on the Gould 64-volt system.

A new alternating current generating plant is being installed at the Northwestern's Fulton Terminal. This plant consists of 250 k. w. unit, 440-volt, three-phase, 60-cycle, which will furnish current for motors aggregating about 325 h. p. Among these are two 75 h. p. slip-ring type motors operating Sturtevant blower fans for a heating system in which the fresh air is blown over steam coils. Current is also furnished to operate two 20 h. p. induction motors in the pumping plant; a 15 h. p. slip-ring type on the turn table; and 40 h. p. induction motor for turning a shaft drive. The alternators are equipped with direct-connected exciters and driven directly by horizontal valve automatic engines.

At Boone, Iowa, a small electrical installation is being made by the same road to furnish power and light for the round house. Alternating current is also to be used there. Sixty k. w., 480-volt, 60-cycle, three-phase generator direct connected to an 80 h. p. single-valve automatic engine is now being installed.

# Practical Stunts by Practical Men

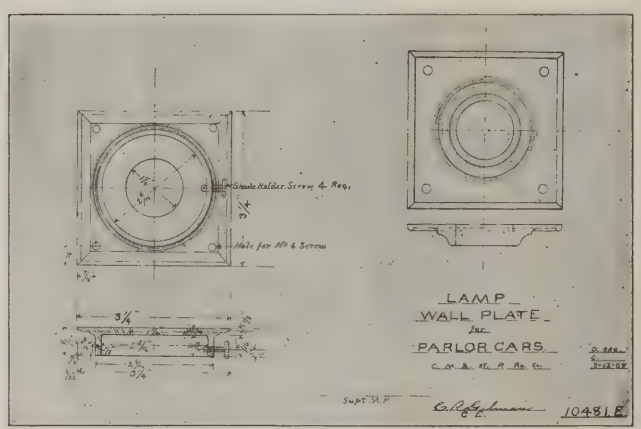
## CHARGING STORAGE BATTERIES.

A safe rule in operating storage batteries on trains is to put an overcharge of 25 per cent into the battery on each trip. That is, for every 100 hours of discharge shown on the ampere hour meter 125 hours should show on the charge dial. This means that the battery is working at an efficiency of 80 per cent which is the correct figure. As it is customary to charge the batteries during the middle of the night and let them carry the load during the early morning hours it is necessary for the train operator to know about what discharge will take place after the charging is finished.

A daily record of the charge and discharge of the batteries it will soon show about what amount of charging is required. This will, of course, vary with the season, but, in general there is no reason why, with amper-hour meters, train batteries should not be operated at very nearly their highest efficiency at all times.

## LAMP WALL PLATE.

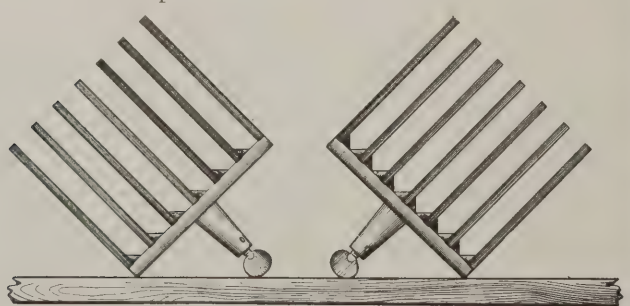
The accompanying photograph shows the details




of a new lamp wall plate now being used on the dining and parlor cars of the C. M. St. P. Ry.

## REPAIRING STORAGE BATTERIES.

The accompanying illustration shows a neat method of sealing lead plates in storage batteries to the connector bar. The jar on trains often causes these plates to become detached and to re-

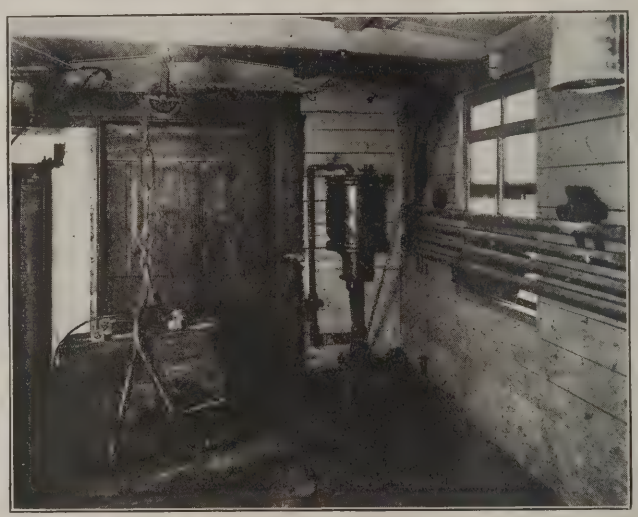


seal them to the bar is a delicate piece of work because of the danger of melting the lead. The scheme here illustrated is to tip the bar sideways and melt the stick of lead with an oxy-hydrogen flame so that it runs into the angle between the plate and the bar and seals them together. The bar is then turned up the other way and sealed in the same manner.

## HANDLING STORAGE BATTERIES.

The accompanying illustrations show two useful schemes devised by Mr. Eisanman, of the Chicago & Alton Railway, for handling storage batteries in the passenger yards.

The first cut shows a compressed air hoist for



Compressed Air Battery Hoist.

lifting batteries onto a small dolly with which they are moved to the proper place in the repair room. The hoist was made out of an old brake cylinder.

The second cut shows a derrick arrangement

Hand Battery Hoist.

with which one man can take out or replace batteries on a car. As these batteries weigh about 175 pounds it is impossible for one man to handle them without some such arrangement as this. In the lower right hand corner a small wheel truck for handling batteries will be noticed.

# General News and Personal Mention

## News Notes of General and Personal Interest to Car Lighting

## MEN AND MANUFACTURERS

### W. M. LALOR.

One of the most widely and favorably known men in the car lighting fraternity is Mr. W. M. Lalor, who has recently resigned his position as manager of the Railway Department of the United States Light and Heating Company to accept a similar position with the Gould Storage Battery Company in New York.

Mr. Lalor is a New Yorker by birth, having, as he says, "arrived and started boarding at home at Utica in 1870." Information as to his activities from then on until he entered Lehigh University in 1898 is meager in the extreme. All he will say is that he was engaged in electrical construction work in the United States, Canada, Central America, Mexico and Cuba. From this wide range of territory it is evident that Mr. Lalor must have been going some. If he had only come through with some details of his experiences during this time this biography might have read more like one of Richard Harding Davis' stories than it does.

W. M. Lalor.

In June, 1902, after completing the course in Electrical Engineering at Lehigh, he entered the engineering department of the Consolidated Railway Electric Lighting & Equipment Co., later holding the position of sales engineer with that company.

The Bliss Electric Car Lighting Company secured his services in January, 1907, as assistant general sales manager. When that company and the National Battery Company were merged into the U. S. Light & Heating Company he accepted the position which he held up till last month.

The Cubs can still make the Giants look like a nine from the long grass circuit, but New York put one over us when she lured away Billy Lalor.

---

The Wagner Electric Manufacturing Company, St. Louis, Mo., announces the removal of its Charlotte, N. C., office to the Woodward building, Birmingham, Ala., to be in charge of J. F. Jones. The Birmingham office will cover that part of Tennessee east of the Tennessee River, and all of the states of Mississippi, Alabama, Georgia and Florida. North and South Carolina, which have heretofore been handled from the Charlotte office, will now be handled from the Philadelphia office, which is located in the Real Estate Trust Building, and is in charge of John Mustard.

### L. R. POMEROY.

Mr. L. R. Pomeroy is now chief engineer of the Railway Industrial Division of the J. G. White Company, Inc., a position which long experience has eminently fitted him to fill.

For the past two years Mr. Pomeroy has been assistant to the president of the Safety Car Heating & Lighting Company. During that time he devoted a large share of his attention to consulting work in the special field of railway shops in machine tool operation with the result that he is now recognized as one of the leading authorities in the country on the subject of the use of machine tools to secure the highest efficiency.

Since 1875 he has been engaged in active engineering work. From 1880 to 1886 he was secretary and treasurer of the Suburban Rapid Transit of New York. Following this he was for four years special representative of the Carnegie Steel Company, introducing the use of basic boiler steel on railway locomotives. Later he was for nine years with the Cambria Steel Company and the Latobe Steel Company conducting experimental research work with the view to developing special steel for railway axles. From 1899 to 1902 he was assistant general manager of the Schenectady Locomotive Works and from then until taking up the work of the Safety Company he acted as special representative for the General Electric Company in the work of electrification of railway motive power and shop equipment.

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### NO INFRINGEMENT.

The United States Court of Appeals has decided that Yost sockets, manufactured by the Yost Electric Co., of Toledo, O., do not infringe on the patents of the Perkins Electric Switch Company, as was alleged in a suit brought by the latter company.

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The United States Light & Heating Company announces the appointment of Mr. W. F. Bauer as manager of railway sales in their Chicago office.

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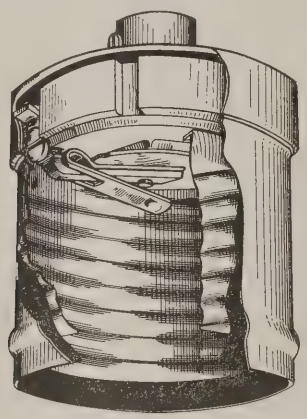
The Edison Storage Battery Company is pleased to announce the appointment of Mr. Harrison G. Thompson as manager of the railroad department, with offices at Lakeside avenue, West Orange, N. J.

## A STEADY CONTACT SOCKET.

In a certain coach on a certain railway an electric lamp fell on the head of a child playing in the aisle. The child's head was badly cut. The child's parents sued for damages—and got them.

As the indirect result of this accident a distinct improvement has been made by the General Electric Co. in the design of their electrolier sockets for car-lighting. The improvement consists of a phosphor bronze spring center contact which permits the lamp to be screwed in tightly and insures a good contact no matter how great the vibration. The lamp can even be turned through a complete



Steady Contact Socket Showing Spring Contact.

revolution and still maintain a steady, unbroken contact.

The advantages of this new socket for use in railway car lighting are at once apparent to any one who has had to deal with that problem. In no place is electric lighting equipment subject to such severe vibration as on railway trains. Lamps without this flexible contact are often shaken out of position. Negro porters seeing them dark are very apt to take them out and put in new ones. Many a good lamp has gone into the scrap heap through this sort of carelessness.

To guard against just such carelessness and against the danger of accident, the new socket has been designed. Like the old style socket it is made with the screw top, single catch, and multi-catch top styles.

## BALATA BELTING.

With the building of a new plant of the New York Leather Belting Company at Easton, Pa., Balata Belting will be manufactured for the first time in this country. This belting is composed of cotton duck and a substance known as Balata gum, a South American product. Specially woven cotton duck is made in the factory itself. The process of weaving is regarded as secret.

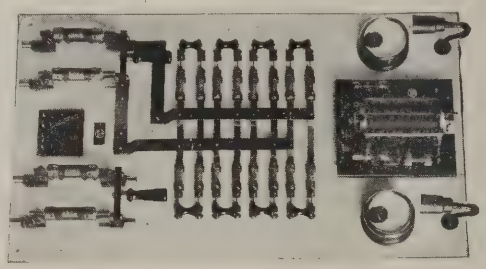
The new plant expects to begin installing its machinery early in September and will be in full operation late in October. When completed it will be the largest belting factory in the world.

## SWITCHBOARD FOR ELECTRIC LIGHTED CARS.

In selecting a type of switchboard to be used in controlling car lighting circuits the choice is largely governed by the available space which is invariably limited. Other considerations are flexibility of control, first cost and maximum safety.

With a full appreciation of the conditions to be met the Delta-Star Electric Co., Chicago, Ill., have designed and developed a type of board which meets all the requirements. The accompanying illustration shows a distributing board which was recently built by them for use on private cars.

The panel, which is of polished white marble 21 x 35 ins., carries equipment for eight branches, one main circuit and one auxiliary circuit. The various circuits are properly protected by fuses of the en-



Delta-Star Train Lighting Switchboard.

closed type, which can easily be replaced. The main switches are specially constructed, being built to carry enclosed fuses in the space ordinarily occupied by the blades, thus effecting a material saving in space.

The instruments are of the permanent magnet, open dial type, compact in construction, and having long open scales. The voltmeter is provided with two scales, the lower 5 volts, and the upper 75 volts in value. The ammeter, which is of the divided scale type, shows charge and discharge, and is operated from a shunt connected to the main switch terminal.

By means of a special contact switch either the 5 volt or 75 volt coils of the voltmeter can be connected in circuit, permitting the full voltage, or the voltage of any individual cell to be measured. The control relay is conveniently located between the instruments and can easily be detached from the board. The entire design and construction is such that it conforms with the other car fittings and offers a practical solution of what has frequently been a more or less troublesome feature of car lighting.

## "DICKBELT."

Some interesting information as to the manufacture of Balata belting has been furnished by R. & J. Dick, Limited, of Passaic, N. J.

About forty-five years ago the late Mr. Robert Dick began a series of experiments in the manufacture of balata belting. In twenty years of experimenting Mr. Dick made many kinds of belting, using balata gum as one of the materials. Eventually he evolved what he considered to be the best form of belting, and patented it under the name of "Dickbelt."

Since that time a large factory in Glasgow has been continually in service manufacturing this belting. It was found, however, that even with extensions, not enough belting could be manufactured to supply the American demand. About eighteen months ago it was decided to erect a factory in America similar in size to the main works on Scotland. This factory is now nearly completed and is expected to be in operation before the end of the year.

The belting manufactured by this new factory will be exactly the same as that made in Glasgow. It is stated that the process of manufacture is a secret known only to this company.

# "NATIONAL" STORAGE BATTERIES

THE STANDARD BATTERY FOR CAR LIGHTING SERVICE

ANY CAPACITY
ANY TYPE
ANY METHOD OF ASSEMBLY

C. L. A.—15 ASSEMBLED IN TWO-COMPARTMENT LEAD-LINED TANK

# BLISS-SYSTEM-MOSKOWITZ
## ELECTRIC TRAIN LIGHTING

**ECONOMY RELIABILITY EFFICIENCY**

These three all-important considerations are thoroughly demonstrated in the **"Bliss"** and **"Moskowitz"** Systems of Electric Car Lighting. Actual figures obtained from operating conditions on a large number of railroads indicate conclusively the superior advantages of these two Systems over all others.

PERFECT REGULATION with LOWEST OPERATING COSTS are assured to the purchaser.

**Communicate with nearest office for complete information.**

## The United States Light and Heating Co.
### General Office: 30 Church St., New York

"Bliss System of Electric Car Lighting." "National" Batteries. "Moskowitz System of Electric Car Lighting."

NEW YORK CHICAGO CLEVELAND MILWAUKEE BOSTON SAN FRANCISCO

# Recent Patents Relating to Car Lighting

## A Review of the Patents Relating to Car Lighting and Allied Subjects Granted

## SINCE OUR LAST ISSUE

**659,818. LOCKING DEVICE FOR INCANDESCENT LAMPS.**

C. J. Timm and J. A. Barnhardt, Duluth, Minn. Application Filed April 27, 1909. For preventing the stealing of lamp bulbs, the inner wall of the socket having a keeper and a spring catch encircling the base of the lamp with a hook to engage the keeper.

**959,303. INSULATOR FOR BATTERY PLATES.**

C. J. Bristol, Des Moines, Ia. Filed Sept. 27, 1909. A notched bar with locking strip for separating storage battery plates.

**959,005. REGULATING RHEOSTAT FOR ELECTRIC MOTORS.**

F. D. Hallock, Pittsburg, Pa. Filed Jan. 3, 1910. Face plate rheostat having field and armature contacts, pair of contact arms and adjustable means for restricting the independent adjustment of one of the arms relative to the other.

**961,145. THERMO-ELECTRIC REGULATOR.**

W. E. Mack, Fort Plain, N. Y. Filed Feb. 12, 1908. For setting the terminals to control the action of the damper-operating mechanism, which operates electrically.

**963,476. CIRCUIT-BREAKING MECHANISM.**

William M. Scott, Philadelphia, Pa., assignor to The Cutter Electrical and Manufacturing Company. Filed Mar. 1, 1905. There are a plurality of electric switches each comprising main and shunt contacts arranged in substantial vertical alignment and the main and shunt contacts of all switches arranged in substantial vertical alinement, the shunt contacts of an upper switch adapted to open before the shunt contacts of a lower switch.

**963,471. CONDUIT.**

Edia R. Ramsey, Penn Yan, N. Y. Filed Oct. 29, 1908. A conduit comprises two strips of material wound one upon the other and a thread passed twice through one of the strips and partially through the other thereof and locking them together.

**963,216. WOOD SEPARATOR FOR SECONDARY BATTERIES.**

Louis H. Flanders, Edgewood Park, Pa., assignor to The Electrical Storage Battery Company, Philadelphia, Pa. Filed Oct. 21, 1908. A separator for storage-battery plates comprises a sheet of wood veneer, wood stiffening ribs, the grain of which extends across the grain of the sheet, and lead tacks for securing the stiffening ribs to the sheet.

**963,284. STORAGE-BATTERY SEPARATOR.**

Ervin M. Fitz, Columbus, O. Filed Feb. 2, 1910. A storage battery separator comprises a perforated plate of insulating material, with oppositely tapered ribs applied to each of the vertical edges thereof, and diagonal ribs extending transversely to the edges across each face of the plate, the diagonal ribs on the opposite sides of said plate extending transversely to each other so as to fully brace the plate.

**963,072. LUXIMETER.**

Walter D'A. Ryan, Watertown, S. D., assignor to General Electric Company. Filed Oct. 15, 1909. A light-transmitting device for photometers comprises a translucent block proportioned to render the light transmitted through the block proportional to the intensity of the light received by a plane surface in the position of the block.

**963,036. HEADLIGHT OR ILLUMINATOR.**

Henry L. De Zeng, Philadelphia, Pa. Filed Oct. 18, 1909. The device comprises a body portion, an electric lamp carried thereby, a concentrator lens carried by the body portion, a reflecting device carried by the body portion and means carried by the body portion for universally mounting the body upon a suitable support.

**964,962. INCANDESCENT ELECTRIC LAMP.**

Edwin W. Rice, Jr., Schenectady, N. Y., assignor to General Electric Company. Filed Sept. 13, 1907. In combination with a metal filament held under tension between supports are means for preventing free vibration of the filament.

**964,994. STORAGE BATTERY INDICATOR.**

Paul Max Marko, New York, N. Y. Filed December 14, 1909. In combination with a storage-battery cell having positive and negative terminals, are a casing inclosing the same, a voltmeter carried by one wall of the casing, a constant resistance (equaling the normal load on the battery and disposed within the casing) comprising an incandescent lamp and an asbestos sleeve inclosing the lamp, the resistance and the voltmeter being arranged in parallel between the terminals of the cell, and the circuit through each being normally broken, the resistance and the connections thereto being supported and concealed by a filling of insulated material between the cell and the wall of the casing.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AXLE ELECTRIC LIGHTING

REQUIRE REPAIR PARTS OCCASIONALLY.

PARTS MANUFACTURED BY US

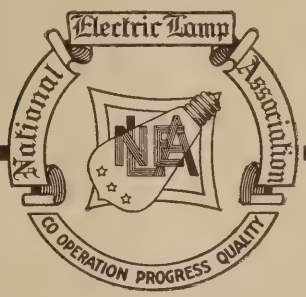
ARE OF HIGHEST GRADE IN ALL RESPECTS.

WE WILL BE GLAD TO BID

ON YOUR REQUIREMENTS.

**OLIVER ELECTRIC & MFG. CO.**

**ST. LOUIS, MO.**




In the effort to supply **the** lamp best adapted to the different problems of electric lighting, the member companies of the National Electric Lamp Association, by co-operative effort, have set the pace of progress and at the same time maintained the highest standard of quality.

Over half a million dollars are spent annually to maintain the slogan of the Association by

**Co-operation** along technical and commercial lines.

**Progress** in the support of an Engineering Department equipped with research and development Laboratories.

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To assure the best lamp value, buy lamps from any of the following member companies of the

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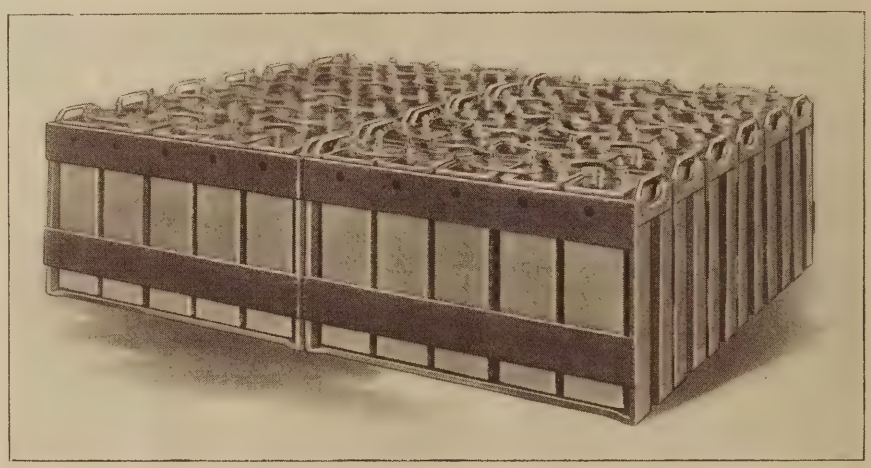
The Banner Electric Company, Youngstown, Ohio
The Buckeye Electric Company, Cleveland, Ohio
The Colonial Electric Co., Warren, Ohio
Fostoria Inc. Lamp Co., Fostoria, Ohio
Monarch Inc. Lamp Co., Chicago, Ill.
Shelby Electric Co., Shelby, Ohio
Sunbeam Inc. Lamp Co., N. Y. City Chicago, Ill.

The Brilliant Electric Company, Cleveland, Ohio
The Buckeye Elec. Lamp Co., S. A. Mexico, D. F.
Columbia Inc. Lamp Co., St. Louis, Mo.
General Inc. Lamp Co., Cleveland, Ohio
Munder Electric Co., Pawtucket, R. I.
Standard Elec'l Mfg. Co., Warren, Ohio
Sunbeam Inc. Lamp Co. Toronto, Ont. Canada

Bryan - Marsh Company, Central Falls, R. I. Chicago, Ill.
The Cleveland Minia Lp. Co., Cleveland, Ohio
Economical Elec. Lp. Co., N. Y. City
Jaeger Elec'l Mfg. Co., N. Y. City
New York & Ohio Co., Warren, Ohio
Sterling Elec'l Mfg. Co., Warren Ohio
Warren Elect. & Specialty Co. Warren, Ohio

# The New Edison Storage Battery

## For Railway Train Lighting



A radical departure from all other storage batteries. No lead or acid in its construction. The Edison is *nickel* and *iron* in *caustic potash*.

Great reduction in weight (60 volt equipment —*2 tons lighter*).

Less space under car body.

Low cost of maintenance.

Long life.

No expensive annual cleaning.

Freedom from buckling, growth, sulphation or internal discharge.

Not injured by standing, either discharged or charged.

Is not injured by overcharging.

**Write for Complete Information to**

**Edison Storage Battery Company, 120 Lakeside Ave., Orange, N.J.**

This illustration shows the beautiful results obtained by "Eye Comfort" system of Indirect Lighting in the Office of the General Western Freight Agent of the Pennsylvania Railroad Co. at Chicago. We can do just as much for your office.

# INDIRECT ILLUMINATION

THE "Eye Comfort" system of indirect illumination increases the working power of your whole force. It provides for clear seeing and clear thinking—prevents mistakes and accidents. The A., T. & S. F., Pennsylvania, C., B. & Q., and C., M. & St. P. Co.'s Trans-Atlantic Passenger Assn. and American Locomotive Equipment Co. have installed this system in their Chicago offices.

Get in touch with our engineering department where data and recommendations will be submitted without cost to you.

**NATIONAL X-RAY REFLECTOR CO., 247 Jackson Boul., CHICAGO**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### ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....92 La Salle St., Chicago.**

The annual meeting of the Association will be held in Chicago Sept. 27-30, at the La Salle Hotel.

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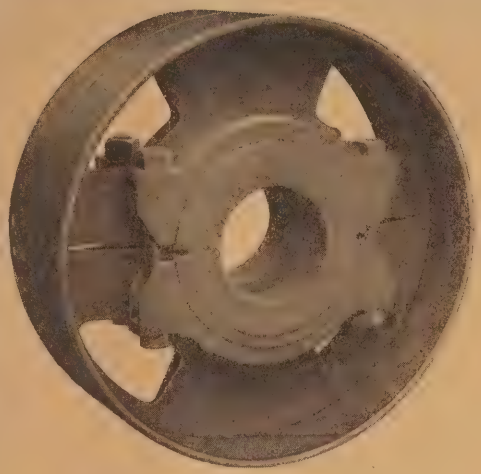

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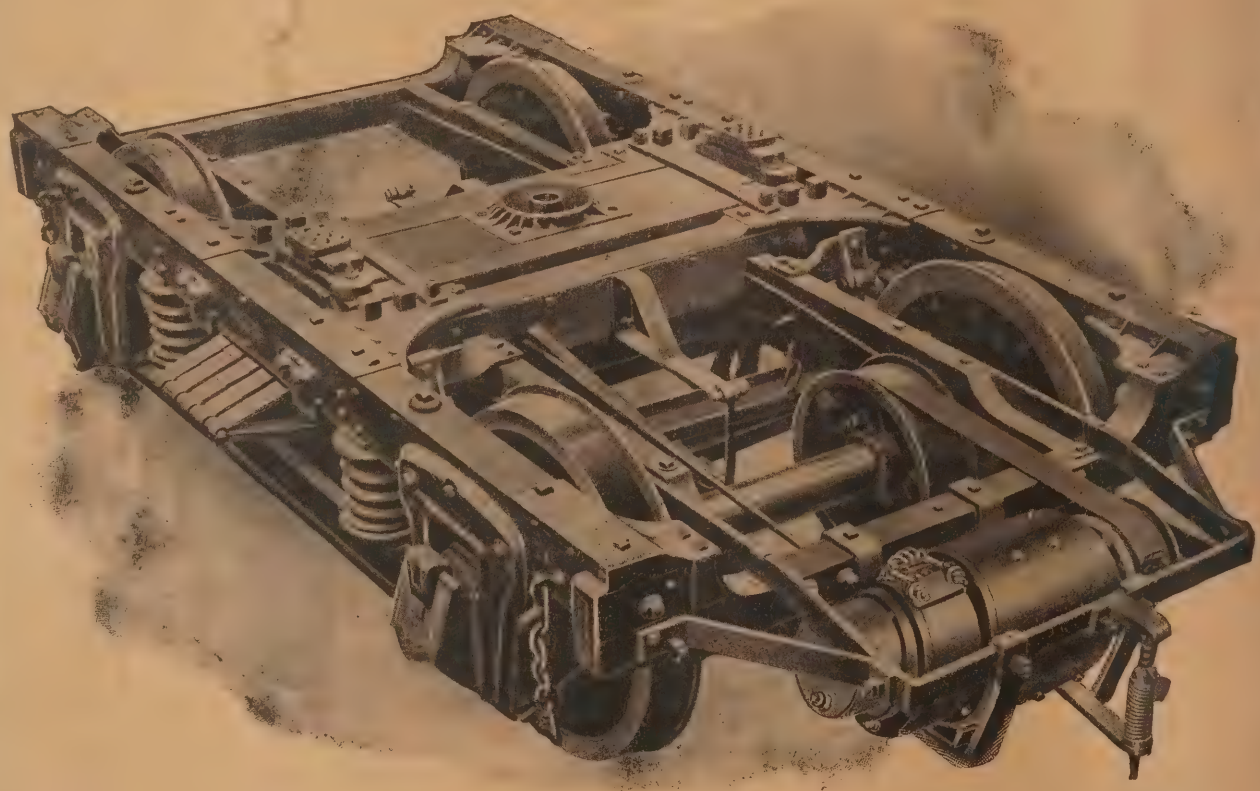

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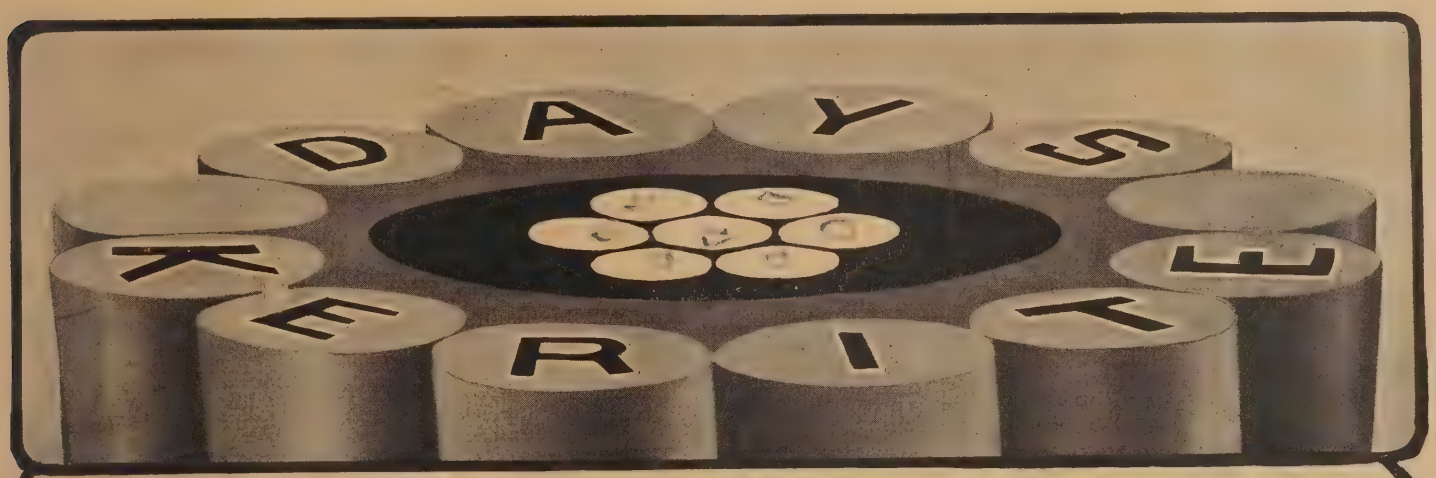
# RAILWAY ELECTRICAL ENGINEER

The Official Journal of the Association of Railway Electrical Engineers

Vol. 2 | CHICAGO 92 La Salle Street | SEPTEMBER, 1910 | $1.00 per year Domestic—$1.50 per year Foreign 10 Cents per Single Copy | No. 4

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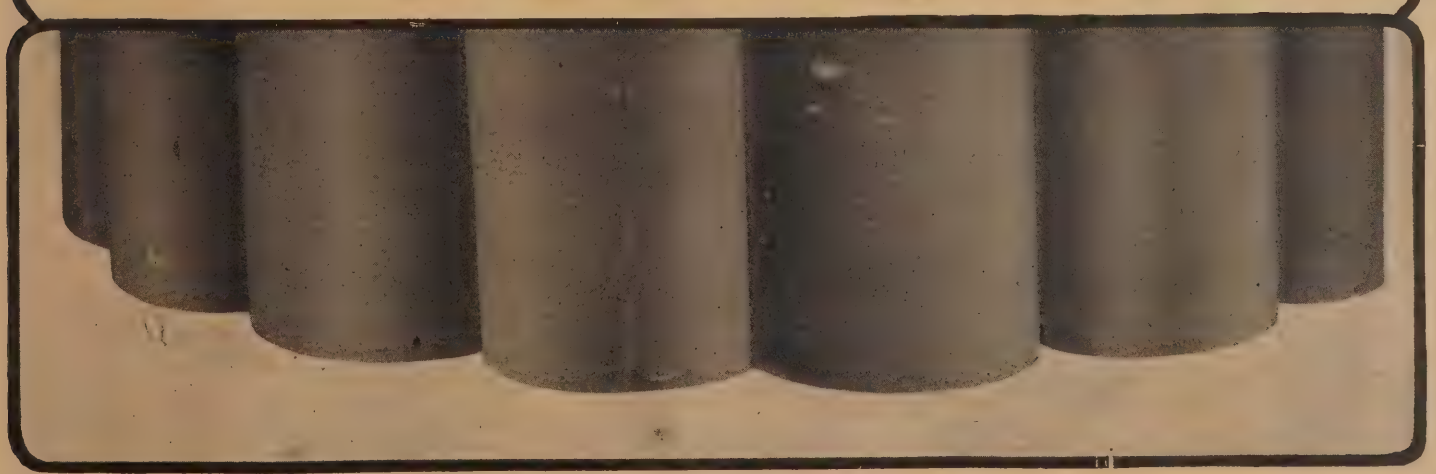

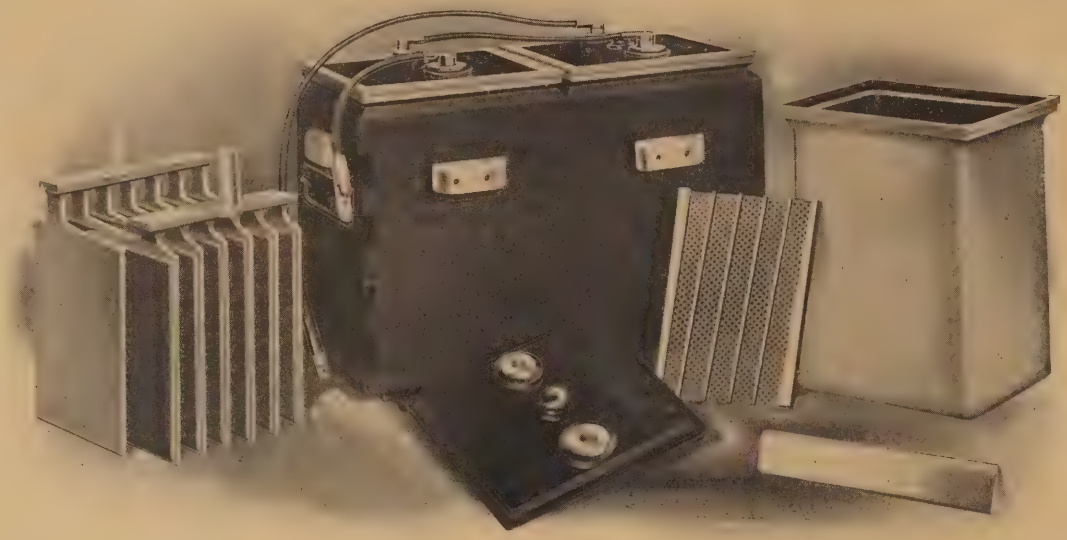

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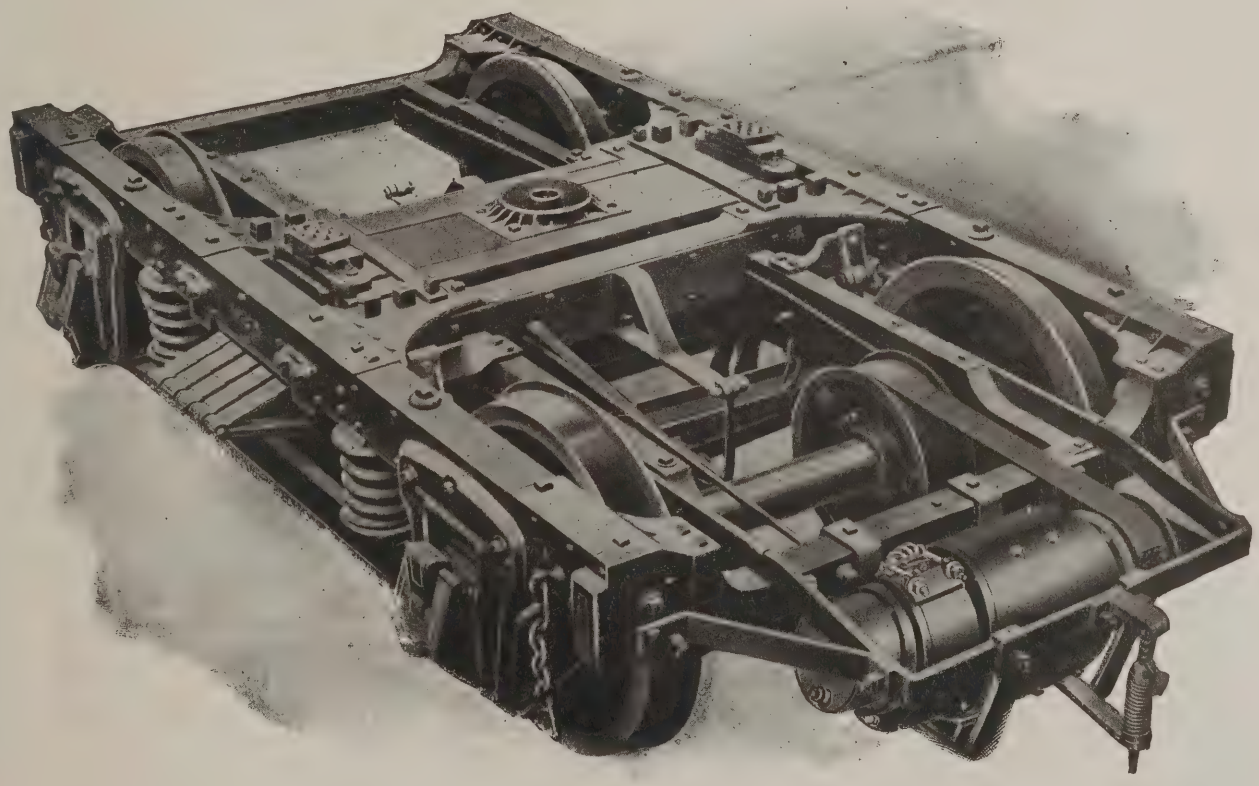

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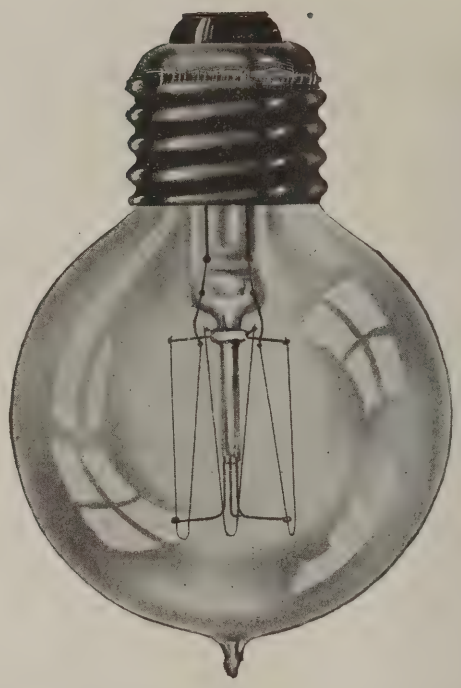

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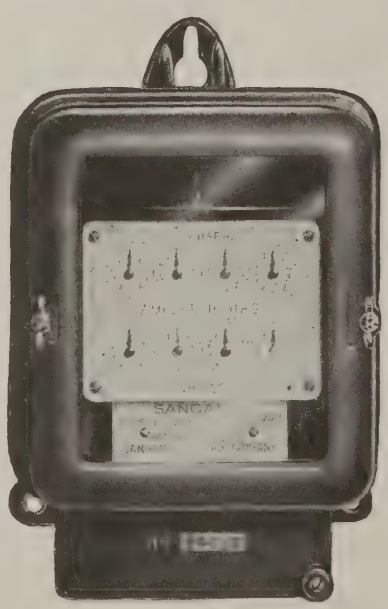

## equipment will increase the life of the battery and provides an absolute check on the entire equipment

When applied to the operation of straight storage equipment the saving in current effected by the meter over that required when charging by the gravity method, will pay for the meter in three months.

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which is of such great importance in the operation of car lighting batteries, can be traced from such factors as manufacturing experience, engineering ability, quality of material and results accomplished.

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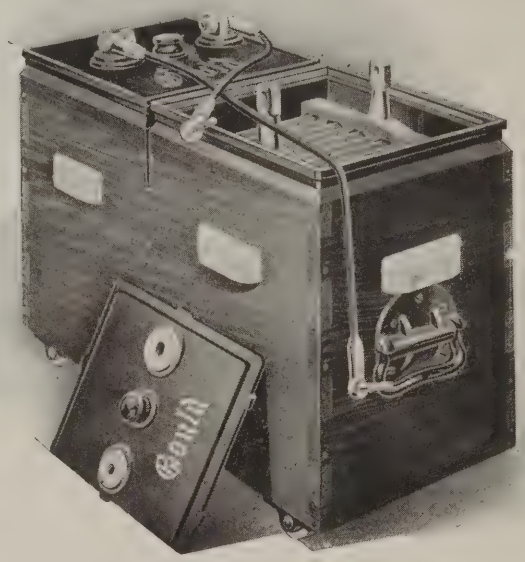


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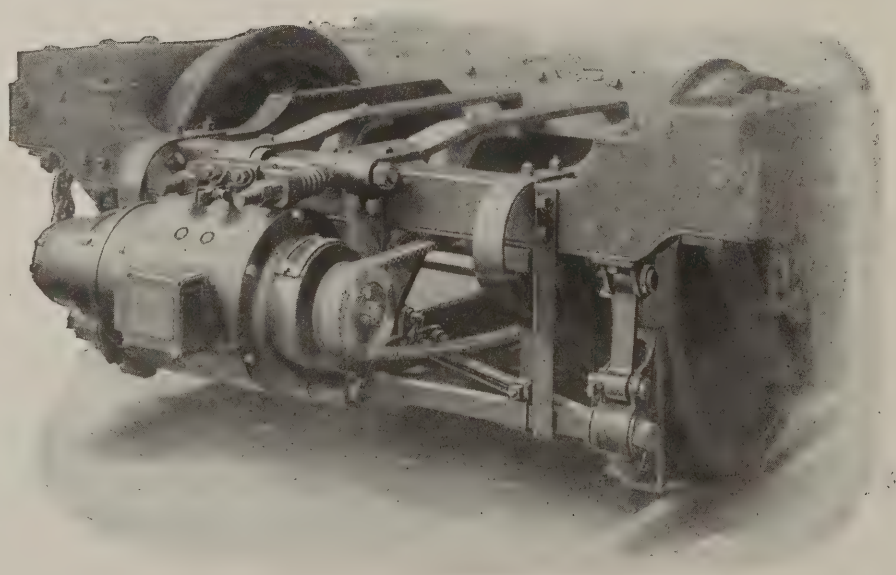

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# RAILWAY ELECTRICAL ENGINEER

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

WRAY PUBLISHING CO.

PUBLICATION OFFICE

92 LA SALLE ST.

CHICAGO

Telephone Main 2457.

EDWARD WRAY . . . . President and Managing Editor
J. G. WRAY . . . . . Secretary and Treasurer
RALPH BIRCHARD.....Associate Editor

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Illl., under the Act of March 3, 1879.

TERMS OF SUBSCRIPTION

United States, Canada and Mexico . . . Per Year, $1.00
Other Foreign Countries within the Postal Union . " " 1.50
Single Copies, Domestic . . . . . 10 cents
Single Copies, Foreign . . . . . 15 cents


OUR OBJECT.

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


Editorials—
Motor Drives ..... 67
Shop Lighting ..... 67
Freight Handling by Electricity..... 68
The Illuminating Engineer..... 68
The Club and the Convention..... 68
The Program ..... 68
Electrical Power in Machine Shops..... 69
Standardization of Motor Drives..... 70
Electric Cranes for Freight Handling..... 72
Line Shaft Drive Vs. Individual Motors..... 73
Safety in Train Lighting..... 75
Motor Drives in the Burnside Shops..... 76
Shop and Power House Illumination..... 77
Test of An Electric Headlighting Set..... 78
Three Methods of Shop Lighting..... 80
Freight Shed Traversing Crane..... 81
High Speed Tools..... 82
Excavation by Electricity..... 84
London Subway Car Lighting..... 84
General News and Personal Mention..... 10
Patents ..... 12
Association Directory ..... 13


## MOTOR DRIVES.

IN the largest machine shop of one of the largest railway systems of the United States, every new machine that has been installed in the last four years is equipped with an individual motor drive.

This plain statement of fact does more to prove the claims of the motor advocates than a volume of theoretical arguments. The shop is not unique in this respect; it is typical of the railway shops of the country. In itself alone, it is large enough to warrant the attention of every mechanical and electrical engineer. Standing as a representative of the trend of the times it becomes tremendously significant. It means that the railroad men—as a class the most careful, deliberate, and conservative men in the world—have been won over to the motor drive through the changing of an opinion often so long held that it had almost become a prejudice. It means that shaft drive will soon be as obsolete as wide flaring stack that once disgraced every locomotive. It means that the electrical engineer is an official of vast and ever-increasing importance to the railway.

Why is the individual motor drive replacing the line shaft power transmission? Because in nine cases out of ten it saves money. How does it save money? It gives better efficiency. It gives better speed regulation. It uses power only when the machine is working. It takes less room. It makes less noise. It is less dangerous. If it breaks down one machine only is put temporarily out of commission. These are some of the reasons. There are others.

There are still some very keen students of machine shop practice who cling to the old line shaft transmission. To convince them it will be necessary to have independent, unprejudiced comparisons of the actual cases. These comparisons are a little hard to make on account of the difficulty of measuring mechanical power.

It is easy enough to measure the power intake of a motor but the power intake of a belt drive is a hard thing to determine accurately. Theoretical comparisons of the two can can be made without much difficulty. To the man on the job they will always be somewhat unconvincing. He knows that many things which look fine on paper fail miserably in actual practice. Figures taken from machinery in actual operation are the only figures that carry weight. The more of these figures that can be secured the better. Incidentally the ease with which they can be secured from electrical machinery is an argument in its favor.

## SHOP LIGHTING.

HOW much of a factor in shop efficiency is shop lighting? In the old days it was not thought very important. So long as the workman could see roughly what he was doing all was well. If he occasionally mistook his thumb for a chip and removed it without ceremony, the loss was his, the company was not out anything. Labor was cheaper in those days, and employers did not realize that individual efficiency, like happiness, is a state of mind. Indeed, the two are nearly synonomous. Other things being equal, the happier a man is the more efficiently he works, providing, of course, his happiness is naturally induced. Good lighting is certainly conducive to happiness and poor lighting destructive of it.

Good lighting costs money. Its most enthusiastic advocates do not attempt to deny that. They contend however, that it saves more than it costs. Let us see about it.

Suppose a man working in an erecting shop drops his wrench. The wrench falls under the locomotive. It is dark as a pocket under the locomotive and he cannot see the wrench. He fishes around with his hands perhaps scraping off a little skin in the process and finally locates it. He has wasted two minutes. If there had been good lighting in the shop the wrench could have been recovered in half a minute with considerable saving of time, energy, and temper.

Let us assume that unpleasant little incidents such as the one described cause the average workman to lose 15 minutes a day. That's a low estimate. Say that these 15 minutes cost the employer 10 cents. That, also, is very conservative. If the shop is a fairly large one employing say 100 men, this time loss aggregates ten dollars a day.

Since the total cost of good illumination for a shop of this size total cost including interest, and depreciation on the lighting equipment, as well as current and maintenance expense—would probably be less than ten dollars per day, and the difference in cost between poor and good illumina-

tion less than five, this one saving will work a real economy.

There are other advantages to good illumination. Not the least of them is that it lessens the danger of accident. Any piece of moving machinery is potentially dangerous. So long as the workman can see distinctly exactly what he is doing, the danger is minimized. Many a shop accident happens at night that would never happen in daytime. Accidents are expensive. They are easier to prevent than to cure.

Just how much a man's working capacity is increased by pleasant surroundings is hard to estimate. Nevertheless there are few who would deny that it is increased. Certainly it is more pleasant to work with good light than with poor light. Good lighting not only saves money. It makes money.

## FREIGHT HANDLING BY ELECTRICITY.

THE business of a railway is to move traffic. About four-fifths of this traffic is freight. When freight is being moved the railway is earning money. When freight is standing still the railway is losing money. In either case the expense for maintenance keeps on about the same.

There is scarcely a railway track in the country but what could accommodate twice as many trains as are now running over it. The hauling capacity is limited by the rapidity with which goods can be loaded and unloaded at terminals. When there is traffic congestion it occurs in the yards.

The haulage capacity of a railway can be increased in two ways. The size of the yards can be increased or the freight can be handled faster. The former is an extremely expensive proceeding. City property is very valuable. In some cities it is almost impossible to secure at any price. Increasing the size of a yard is almost certain to increase the length of team haul between the cars and the warehouses. The second method is the one which will have to be generally adopted.

How can freight be moved faster at terminals? Electricity solves the problem. With small traveling cranes such as that now in use on the Great Western Railway at Cardiff, England, good sized pieces can be handled at a speed which the best laborers in the world could not possibly approach.

Oftentimes freight can actually be handled more cheaply by machinery than by hand. Whether it can or not is relatively unimportant. The important thing is that a railroad's income is dependent upon the volume of freight handled, and the volume is limited by the speed of terminal handling. The electric crane is the stevedore of the future.

## THE ILLUMINATING ENGINEER.

OUR interesting contemporary, *The Illuminating Engineer*, devotes considerable editorial space in the August number to "Railway Illuminating Engineering, an important but neglected field." After mentioning at some length several railway lighting problems it arrives at the following conclusions:

"Notwithstanding all of these vitally important illuminating engineering problems we are not aware that a single railroad has an officially recognized illuminating engineer. It is time that this anomalous condition of affairs should be reformed. Every railroad should have an illuminating engineer who should have final authority in all matters pertaining to artificial lighting, and be responsible directly to the general manager of the road. Illumination is not a side issue nor a sub department, but is a subject of primary and distinct importance. The economies which could be secured by such a course would make the maintenance of a department of illuminating engineering a most highly profitable investment.

A general survey of the present practice of lighting in connection with railways undoubtedly leads to the same general conclusion, and there is no gainsaying the fact that there is no great enterprise in the country today that stands so badly in need of the services of competent and specially trained illuminating engineers as the railways."

We do not believe the situation is quite as bad as our friend *The Illuminating Engineer* seems to think. There is undoubtedly room for great improvement in railway lighting, but rapid strides in that direction are being made. Cars are being equipped for electric lighting as rapidly as possible. Nearly all the new equipments are designed carefully to fit the peculiar requirements of this form of illumination. The carbon filament is being replaced with tungsten. The bare lamp is giving way to the judicious use of shades. Car lighting is coming to be recognized as an art.

Railway illuminating problems are problems for the electrical engineer. The superiority of electricity over gas and oil for train lighting is so evident that train lighting is necessarily an electrical problem. There is room for gas in station lighting perhaps, but even there the flaming arc is rapidly coming to dominate the situation. It is a mistake to say that the railroads are without illuminating engineers, for many of the railway electrical engineers are illuminating engineers—and good ones.

## THE CLUB AND THE CONVENTION.

THE Car Lighting Club will hold its first meeting of the season on the evening of Wednesday, September 7th, in the main dining room of the Chicago Press Club at 118 Dearborn Street. Theoretically the subject for discussion will be a report of the Committee on Voltage Regulation and Illumination. Practically it will probably be largely the coming convention.

And while we are on this absorbing subject it might not be out of place to say a few words ourselves.

From present prospects this convention is going to break all previous records so badly that they will never be mentioned again. In fact, to hear the talk, we are almost beginning to believe that the year 1910 will go down in history as the year of the Big Convention. Exhibitors are clamoring for space; decorators and caterers are laying in supplies; all over the country the railway electrical men are laying plans to be there. Incidentally we are planning to smash a few records ourselves in the cause of electricity. If the convention number keeps on developing as it is now, there is no telling how big it may be. Our aim is to have it contain everything that is new and interesting in the railway electrical field. This is a rather high aim, but we are going to go a long ways toward it.

## THE PROGRAM.

THIS issue of the paper was held as long as possible in hopes that we would be able to print the complete program for the convention. In this we were disappointed, but we are able to give a rough outline of what is going to happen.

Monday night will be given over to a reception and dance.

Tuesday night will be Ladies' Night, and all of the fair are expected to see what their husbands or admirers (and admirers?) are up to.

Wednesday afternoon the ladies will again come in, this time on a matinee at one of the theaters.

Thursday night, the banquet.

The complete list of the papers is as yet unavailable, but the following subjects have been definitely provided for:

"Alternating Current Motors in the Operation of Railway Machine Shops."

"The Electrification of Steam Railways."

"Electrical Operation of Bridges and Turntables."

"The New Edison Nickel-Steel Cell."

"Ventilation of Passenger Cars."

# Electrical Power in Machine Shops*

## A General Discussion of the Methods and the End in View

C. H. PALMER

The electrical powering of machine shops in the most economical manner is a problem which may now be said to have been thoroughly mastered by electrical engineers. The essential factors which have to be considered in the powering of any plant are dependent upon the economic production of the output, the nature of the products handled and the possibility of future development. It may be positively stated as a well established fact resulting from comparative tests on steam and electrically driven plants that in the former only about sixty-six per cent of the power generated is delivered to the machines actually doing work, in other words, full one-third of all the power produced in the mechanically-driven equipment under full load, is not available and may be said to be lost; it is in fact absorbed during its transmission from the engine to the point of application. This loss is practically constant, regardless of the number of machines in operation; actual tests have shown that the average load factor is about fifty per cent in most steam power plants; whilst in the electrically equipped plants the efficiency varies slightly, according to the load, and is as high as eighty-five per cent at half or three-quarters load. Electrical equipments may now be considered standard and the benefits are so generally recognized that a great many engineers advise their adoption.

The positive result of an electrical equipment is a reduction of the unit cost; it has been much discussed as to decreased cost of operation and decreased cost of equipment, points which are true in the main, but which do not do justice to it. The capital used may be larger and the operating cost may be more, on the other hand more work is turned out in the same time, so that when the unit cost is worked out, it is found to be much reduced.

Considerable flexibility should always be allowed for in the power-house units and in the designs of the equipments; thus a selection of three small units instead of two large ones may appear to be an extravagant expenditure, when first suggested, but after a few years of natural development, it is usually found to be more satisfactory for an even distribution of load and for a sufficient emergency capacity. Machine tools, it need scarcely be stated, are designed to withstand given strains and stresses in connection with shafts, bearings and so on, and it is uneconomical to try to make a tool do less work than it is constructed for, as is is uneconomical to make it do more work than it can safely stand. The difference between the electric drive and the ordinary drive is that with the latter the machines are connected to their source of power in such a way that when they come to an overload point they refuse to take the power, causing the belts to slip, the excess power being used up in friction; while with the direct-connected motor drive, the machine is not given this alternative and it is in this respect that the engineering precision required by the motor drive means its greatest source of power saving, by holding each machine at its most efficient load. Engineers necessarily differ as to the details of the electrical system most suitable for machine shops; broadly two systems may be mentioned, quite distinct from each other: the alternating-current and the direct-current systems; these two may also be combined; thus the alternating currents may be used as the main units with the direct current as an auxiliary system, or the direct current for main units and the alternating for auxiliary.

Probably the balance of opinion in Great Britain is in favor of the alternating-current system, with facilities for conversion to direct current, as it has been found to be both economical and reliable. For constant-speed running the induction motor is very suitable and extremely economical; whilst some machines requiring adjustable speed are best operated by direct-current motors, as it would otherwise be necessary with alternating-current motors to provide complicated mechancial speed-changing devices. On a large system the generators and motors are simple and reliable and the wiring is much smaller; but with buildings distributed over a large area and transmission over long distances, the alternating-current system is preferred, as it economizes energy from the switchboard to the machines themselves. The advantages claimed for electrical driving are cleanliness, convenience of placing machines without reference to power supply, facility of motor control and automatic operation; to a considerable extent the elimination of belts and loose pulleys, more light, less noise, increased safety from accidents to workpeople; but the essential advantage is the reduction of the unit cost.

The alternating system has the advantage of reduced loss of energy between the switchboard and the machines requiring the energy, when the distances over which current must be transmitted are considerable. Current can be generated at high voltages and can be transmitted throughout an alternating-current distributing system with a considerable saving in copper, as well as a reduced loss of energy in transmission; but a limit is placed upon the transmission voltage of such a system, as auxiliary apparatus is necessary in the way of transformers to bring the voltage of the system down to a practical operating voltage. It follows that a point may be reached when a saving from reduced copper and energy lost in transmission is offset by an additional outlay for apparatus.

In the case of a plant having all its departments closely centered, compactly arranged and having an equipment consisting of variable-speed machinery, the direct-current system is undoubtedly the proper solution, with individual motors wherever possible; but for a plant which covers a large area and has an equipment demanding large amounts of current, of which only a small portion is used for variable-speed machinery and which is of sufficient size to require separate units for the lighting service, alternating current is strongly insisted on by most European engineers. No very hard and fast rule can be laid down as to which system would be most economical, as conditions are often very complicated, requiring most minute investigation of the installation and a thorough knowledge of the power demands and in addition some knowledge of future expansion. In some conditions therefore it may be confidently stated that the alternating-current system is the most economical and suitable; whilst in other cases in which the character of the power service is more or less varied a careful study of the conditions is imperative before a decision or choice can be made.

There are two types of motors available for the alternating-current system, the induction motor and the synchronous type. The latter is not self-starting, and with the exception of some cases its use for machine tool driving may be said to be limited. It is, however, distinctly desirable in connection with induction motors for steadying the line and improving the power-factor in cases where heavy shafts have to be run for some considerable length of time.

*Electrical Review.

The induction motor is self-starting and tends to run at a constant speed; this type of motor may be adapted to variable-speed service, although primarily available for constant speed. In those installations using alternating-current motors, principally on constant-speed machines, the induction motor, in connection with a mechanical speed-changing device, generally proves very successful for variable-speed demands. The constant speed characteristics of the induction motor make this type especially suitable for machine-shop application. When the load is put on a motor its speed falls until the induced electromotive force in the secondary is sufficient to develop the torque required for the load.

There are three types of motors, based on the direct-current system the characteristics of which may be said to cover very completely the requirements of machine-shop tool driving, namely the compound-wound, the series and the shunt-wound varieties. The first of these is applicable where small variations of speed are needed coupled with a large starting torque and when set for certain conditions this type of motor operates at a constant speed. The series motor has a variable speed with great starting torque and can be controlled throughout its whole range of speed. It is, however, very uneconomical, as the control is obtained by resistance in its circuit, requiring an expensive controller on account of the heavy currents handled. The speed varies inversely with the load, so that at light loads the speed attained makes it dangerous to the construction of the armature. This type of motor is very suitable for elevators, hoists or cranes. The shunt type may be described as a constant-speed motor, as when it is set to run at a given speed it will not vary much under a varying load up to its capacity. It is possible, however, to make the motor vary in speed in several ways. By changing the current in the armature, by varying the strength of the field and by varying the voltage applied to the armature terminals, a variety of speeds may be obtained. All engineers will recognize that these characteristics make the shunt motor the most suitable of any type of direct-current motors for the purposes of machine-tool driving. By means of these three methods of control either singly or in combination with each other, this type of motor can be made to fulfil the requirements of both variable and constant-speed machines.

Cases occur in the electric powering of machine shops where it is possible to obtain current by purchase from a central power company delivering alternating current; a combination is then possible forming an alternating-current direct-current system, which has several points in its favor, especially in the case of works placed on a straggling site of large area. When power is thus obtained the voltage has to be reduced to the required value by means of transformers at the distributing board of the plant and the low-voltage alternating current can then be used for all power requirements except for driving variable-speed motors and auxiliary apparatus. For machine shops there is this objection to the arrangement that they are reduced to practical idleness in case of a breakdown at the source of supply. When works have their own generating equipment, a system not subject to such eventualities, as well as an economical layout is assured; alternating current can be used for all constant speed and lighting, while motor-generator sets or a rotary converter can be provided to supplement the system and to supply the direct current for variable-speed motors and auxiliary apparatus.

It has been found expedient in machine shops to provide an individual motor drive for drill-presses, radial drills and other machines of the class, which are usually provided with change-of-speed accessories; consequently a constant-speed motor is suitable. Direct-connected motors are also suitable to drive punches, shears and bending rolls; this type does not require variable speed, it follows that an alternating-current or direct-current constant-speed motor is very suitable. Motors for actuating traveling cranes have become very general. The saving in power and other advantages of a carefully thought-out electric-drive installation for machine shops is now fully appreciated by all who have carefully studied the subject.

# Standardization of Motor Drives

## Report of the Committee of the National Machine Tool Builders Association

At the spring meeting of the National Machine Tool Builders' Association, the Committee on the Standardization of Motor Drives for Machine Tools reported on the progress which has been made in the negotiations which have been carried on with the American Association of Electric Motor Manufacturers. The committee, which consists of P. A. Montanus, F. R. Ratliff, and A. L. DeLeeuw, reports that seven points have been agreed upon by the representatives of the two associations and these points are published in the report which we present below. The final adoption of these points has not yet been taken up by the two associations.

**1. Horsepowers.**—It is thought that the following horsepowers will meet practically all the requirements of electric drives for machine tools: 1, 1½ (for D. C. only), 2, 3, 5, 7½, 10, 15, 20 and 25. Though it was agreed that horsepowers more than 25 and less than 1 are used, it was not thought advisable to embody them at the present in the attempted standardization, but is was held out that they might be embodied some time in the future among the standardized sizes. The chief consideration was to limit the demands to the lowest practical amount, so as not to defeat the object of your committee at the start by insisting on more than the electrical people could grant.

**2. Voltage.**—It is recommended that for D. C. motors 115 and 230 volts be adopted as standard, and for A. C. motors 110 and 220 volts.

There is now a good deal of confusion as to voltages for D. C. motors. The motor manufacturers have reached an agreement among themselves as to these voltages, and 115 and 230 voltages recommended by them represent the nominal voltage of the system, and not the real voltage at the motor.

**3. Horsepower Ratings for Drives.**—It is recommended that the horsepower ratings for machine tool drives be the standard ratings of the American Association of Electric Motor Manufacturers—i. e., (a) that motors be given the continuous constant horsepower rating where approximately standard load conditions exist; (b) for adjustable speed motors used for intermittent service the standard two-hour continuous duty rating be used for ordinary shop conditions, and that the name plates of such motors indicate the time as well as horsepower ratings of the motor, and further that the horsepower be figured at the high as well as the low speed for adjustable speed service.

**5. Speeds.**—The following table of speeds is recommended as the standard for adjustable speed D. C. motors:

| h.p. | 2:1 | 3:1 |
|---|---|---|
| 25 | 900—450 | 900—300 |
| 20 | 900—450 | 900—300 |
| 15 | 1,200—600 | 1,200—400 |
| 10 | 1,200—600 | 1,200—400 |
| 7½ | 1,200—600 | 1,200—400 |
| 5 | 1,200—600 | 1,200—400 |
| 3 | 1,500—750 | 1,500—500 |
| 2 | 1,500—750 | 1,500—500 |
| 1½ | 1,500—750 | 1,500—500 |
| 1 | 1,500—750 | 1,500—500 |

The tendency of the electrical manufacturers is of course toward higher speed motors, but is was though desirable by your committee to hold out for lower speeds, on account of mechanical difficulties in gear and chain driving when higher speeds are used. The schedule as given above is a compromise, and will allow of motor drives with reasonable linear speed of first driving gears, and limits the number of revolutions of the motor to within the limits given by chain makers for the proper speed of their chains.

**6. A. C. Motors.**—It is recommended that the following table of polyphase 60-cycle A. C. motors be adopted:

| | | |
|---|---|---|
| 25 | hp | 900 and 600 |
| 20 | hp | 900 and 600 |
| 15 | hp | 900 and 600 |
| 10 | hp | 1,200 and 600 |
| 7½ | hp | 1,200 and 900 |
| 5 | hp | 1,200 |
| 3 | hp | 1,200 |
| 2 | hp | 1,200 |
| 1 | hp | 1,800 and 1,200 |

**7. Frequency.**—For the consideration of the constant speed A. C. motors, 60 cycles is to be used as the basis.

Points 8 up to 15 were not jointly discussed by the Electric Committee of the Motor Manufacturers' Association, and are given here below, to show you in which direction your committee wishes to accomplish the standarization.

**8. Shaft Diameter.**—It is recommended that the shaft diameter be figured according to the formula $D=C\sqrt{\frac{H.P.}{S}}$ in which C is a constant to be agreed upon by motor manufacturers, D the diameter, and S the speed; it is further desired that all diameters up to and including 1½ in. be given in ⅛ in., and all diameters above 1½ in. be given in ¼ in.

**9. Length of Shaft.**—It is recommended that there shall be a fixed proportion between diameter and length; the constant to be determined by the motor builders. Further, that the shaft be rounded at the end.

**10. Keyways.**—It is recommended that keyways be made for square keys, and that the key be equal to one-fourth the diameter of the shaft.

**11. Driving Fit.**—It is recommended that there be added to the standard dimensions of the shaft .0005 in. for every ½ in. diameter of the shaft or fraction thereof.

**12. Variation.**—It is recommended that shafts shall not be under the specified size, but may exceed same by .0005.

**13. Height of Center.**—The height of center to be given in full ¼ in., and shall not be less than figured dimension, but may exceed this dimension by one thirty-second.

**14. Clearance Circle.**—It is recommended that the clearance circle around the motor shall have a diameter of ½ in. less than twice the center height.

**15. Base.**—All motors to be held down by four bolts. Bolt holes to be drilled one-sixteenth above the bolt required. Bottom of motor to be planed parallel with the shaft of motor. It is further recommended that the bolt holes be placed in a configuration of constant proportions, preferably in a square, and that the dimensions of this configuration be made a function of the horsepower divided by the speed, and further that all dimensions be given in the nearest higher ¼ in. The feet of the motor should extend beyond the body sufficiently to allow for drilling and reaming of a dowel pinhole while motor is in place.

**4. D. C. Motors.**—It is the recommendation of the Joint Committe that constant speed motors, adjustable speed with a range of 2 to 1, and adjustable speed motors with a range of 3 to 1, be included in the attempt at standardization. It is the opinion that this will cover practically all the requirements of the majority of machine tool manufacturers, and these ratios are recommended for the guidance of tool and motor designs.

This does not exclude the occasional use of motors with a different speed range, such as 4 to 1, or even more, but it was the opinion of the committee that motors with a higher range of speed than 3 to 1 are not used to a sufficient extent and are not so absolutely necessary for machine tool construction, as to include them among the standardized motors.

## IDENTIFICATION PLATES ON AXLE SETS.

The Southern Pacific Company (Pacific System) has arranged to place identification plates on all their axle lighting sets. On account of the number of cars from other points running over the Southern Pacific lines, and the frequent transfers of equipment from one car to another because of shop repairing, change of runs, etc., it has been found necessary to have some means not only of identifying the ownership but also the number of the equipment.

In regard to this Mr. E. M. Cutting, engineer of train lighting, heating and ventilation on the S. P. lines, says:

"While it is admitted that the plate could be easily removed by unscrupulous persons, thus destroying the identity of the equipment, it has not been our experience that trouble arises so much from maliciousness as from confusion in the reports and records. I, personally, would advocate that some such identification plate be applied to all axle light equipments. It would be of great assistance to all concerned, particularly in those cases where the equipments of foreign roads require repairs. Under those circumstances it is difficult, sometimes impossible, to determine the ownership of the equipment for the adjustment of accounts."

## EDISON BATTERY CAR.

Further tests of the Edison battery car used on a cross-town route in New York have been published. The route is 4.7 miles long and has 46 curves and a 3.5 per cent grade 1000 ft. long; the car weighs, empty, 10,000 lb., and with an average load, 12,400 lb.; its equipment consists of two 5 h.p. 110-volt motors and 100 A-8 Edison cells for traction. During the three months of the test the car was on the road 1,132.5 hours and covered 5,152.5 miles, which was an average of 57.25 miles per day of 12 hours 35 min. The battery is charged once a day, the charge lasting 4.4 hours and taking place at 185 volts and 60 amperes. The total daily energy input to the battery is 48,840 watt-hours, and the battery output measured at the motor brushes is 30,280, giving an energy efficiency of 62 per cent. Reducing the total energy consumption to a unit basis, the gross energy input to the battery for this service was 137 watt-hours per ton-mile, and based on motor consumption, 85 watt-hours per ton-mile, the schedule speed being 4.77 miles per hour with eight stops per mile, and an average running speed of 5.74 miles per hour. Up to the present date the car has run more than 10,000 miles on the worst kind of track and in all kinds of weather. During this period there have been no repairs to the car or battery except the renewal of one motor brush and the addition of 70 gallons of water to the battery.

# Electric Cranes for Freight Handling

## Some That Are In Use and Something of Their Advantages

In our methods of handling freight at terminals we are notoriously inefficient. In spite of the high cost of labor, the human truck horse still does practically all the intermediate work between the car and the dray. In this respect our transportation facilities have advanced but little in the last 50 years. If anything they have retrogressed, for the strength of men cannot be efficiently applied to the large and very heavy parts which now make up a considerable proportion of our freight traffic.

The use of cranes and derricks is about as old as civilization. The Egyptians must have had some good ones when they built the pyramids. The hand-power crane had its uses but it represents no great advance over hand labor. The steam crane is inefficient and wasteful of power. A compressed air crane of any size requires a rather expensive machinery outlay to keep it running. The electric crane, on the other hand, will handle anything from a wheelbarow to a 30 foot monolith. It will work faster than any other power, and because it uses current only when working, and requires no outlay for other machinery.

There is probably no place in the world where more heavy materials are being handled all the time than in Chicago. And it is encouraging to note that the electric crane is coming into extensive use for handling this freight. Within a radius of 2 miles seven electric cranes are in daily operation in Chicago railroad freight yards. They are used at present chiefly in handling structural steel and building stone and are all of comparatively large capacity.

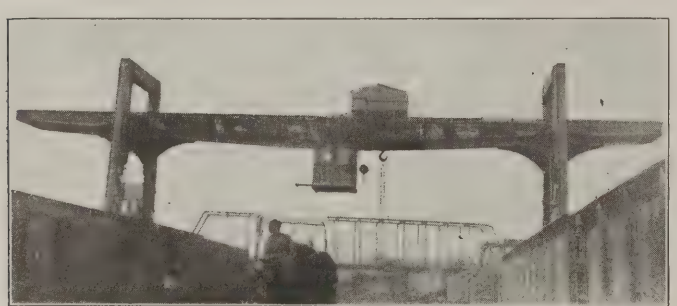


Fig. 1. Electric Crane of Pennsylvania Railway.

All of them travel on two single rails through a distance of 300 to 400 feet. Some cover two tracks and some four, with a roadway between where the wagons or drays receive the material from the cars. In the majority of cases the power is bought from a central station. The Michigan Central yards on the river near Rush street, however, are equipped with a power house containing two small Bullock Generators of 112 amperes capacity at 220 volts which furnish power to the crane as well as current for lighting the yards and offices.

The crane shown in Fig. 1 is owned by the Pennsylvania Railway and is located in the west side yards near Halsted street. It is typical of all of them. This crane has a total span of 85 feet, covering four tracks and a 30 foot block paved roadway. It is operated by 3 series motors of 220, 35, and 3 H. P. respectively, and has a lifting capacity of 40 tons. The 35 H. P. motor turns a shaft which extends down the upright and is connected to the wheels by a bevel gear and pinion. It is able to move the crane along the track at a fair speed. The 3 H. P. motor moves the carriage back and forth across the span, while the other motor does the hoisting.

Fig. 2 shows the crane in use in the Rush Street yards of the Michigan Central. It is similar in many respects to the one just described and is used largely in handling heavy building stone. A feature of this crane is that it has two hoists which may be used separately or coupled together to give a total hoisting capacity of 25 tons. Although this is the nominal duty of the crane it is stated that it has lifted more than this at times, on one occasion

Fig. 2. The Michigan Central's Chicago Yard Crane.

raising a weight of over 40 tons without any disastrous results.

The crane shown in Fig. 3 is owned by the Pennsylvania. It is somewhat smaller than the others, and covers only two tracks. An interesting feature of this crane is that it uses 3 phase alternating current, taking the power from two wires by a double trolley.

It would seem that the electric crane might well be built in smaller sizes for handling the many articles of freight which are just too big to be easily trucked by hand. Much material that it now being trucked could be moved far faster by electricity.

When the question of expediting freight traffic comes up for discussion the chief delaying factor is found to be not the slow speed of the trains but the slow transfer of freight to and from the cars.Anything that facilitates the handling of freight increases the income of the road. The maintenance of a track and roadbed costs practically the same whether 10 trains a day or 20 run over it. And this maintendance charge constitutes a very large proportion of the operating expense. Therefor, it may be highly profitable to handle freight at terminals at twice the expense if it can be handled twice as fast.

Fig. 3. A Crane in Use in the B. & O. Chicago Yards.

This is coming to be realized by the railway traffic departments, and many more cranes will soon be installed.

# Line Shaft Drive Vs. Individual Motors*

## Economies of Motors Shown by Close Comparisons of Actual Installations

A. G. POPKE

Power for the operation of machine tools may be furnished either by individual motors or from a line shaft. In laying out an installation of machine tools, the relative merits of the different methods of drive should be carefully considered. The first cost of drive from a line shaft is usually less than by individual motors. In a great many cases a line shaft drive has been installed without giving due consideration either to the advantages or the savings which can be effected by an individual motor drive.

The writer has at hand a number of experimental tests from which the following analyses have been obtained. Formerly practically all shops were driven from long line shafts and the speed regulation was very poor. A breakdown anywhere in the shop would then shut down the whole system. So simple a thing as a belt leaving its pulley was likely to cause a cessation of work for a considerable length of time. More recently the steam engine has been replaced in many cases by one large motor, thus securing more uniformity in speed regulation. Then came the division of tools into groups with an individual motor for each group. By this method even better speed regulation is obtained and there are fewer general delays.

For most kinds of service, however, the advantage of making each tool independent of others has become apparent to close observers. It is found that with individual motors higher speeds and deeper cuts are possible. The water-hardened steel cutting tools formely used would not permit this, nor was the structure of the old line shaft tools strong enough to stand the additional stresses due to the heavier cuts. High speed steel came to meet the first need, and stronger construction soon brought the machine tools in line. To the advent of the electric motor, then, can be ascribed the commercial development of high speed steel and many improvements in machine tool construction.

Increased economy in the operation of manufacturing machinery can be effected in two ways:

1. By reducing the power required to operate the machinery.

2. By reducing the time required for a given operation, or, in other words, increasing the output in a given time.

When confronted with the problem of deciding between the continued use of an existing line shaft or individual motor drive, or when deciding between the two methods for a new installation, the problem should be impartially considered in all its phases, somewhat as outlined in Table 1. This table includes every important item to be considered, except one, and in every case the advantage is on the side of the motor.

Comparative cost is possibly the first consideration to enter the minds of most men, and this is the one consideration purposely omitted from Table 1. That this consideration is relatively of minor importance, is evident when the saving in power consumption and in time made possible by the use of individual motors is considered.

### Economy in Power Consumption.

In order to determine the power required to drive line shafting and to obtain data for making accurate estimates, tests have been made by the aid of a graphic recording meter on motor-driven line shafts. The fact that these shafts were motor-driven gave them some advantage over engine-driven shafts, and made accurate measurements possible. Otherwise the method of driving the line shaft need not be considered here. In each case the line shaft was belted to short counter-shafts from which the machine tools were driven. In the following discussion all references to the power required to drive the line shaft are understood to include the power requirements of the counter-shafts and connecting belting.

Test No. 1. This test was made on a lightly loaded line shaft driving three machine tools, the conditions being as follows:

Length of main shaft, 115 feet.
Diameter of main shaft, 3 inches.
Self-oiling bearings every eight feet; dimensions 3 in. x 12 in.
Couplings every 24 feet.
Driving motor, 40 h. p., 720 r. p. m.
Machine tools—

| | |
|---|---|
| One 14-ft. boring mill; maximum power requirement | 3 kw. |
| One 48 in. x 10 ft. planer; maximum power requirement | 2 kw. |
| One 10 ft. x 20 ft. planer; maximum power requirement | 3 kw. |
| Maximum power requirement with all tools working at maximum output | 8 kw. |

The test showed that 4.5 kw. input to the motor was required to drive the line shaft with no machines operating. Tests lasting over several hours showed that the machines while operating under existing shop conditions required an additional average input of only about 1.5 kw.; that is, the total motor input was approximately 6 kw. Of this amount the line shaft required 75 per cent. and the machine tools only 25 per cent, including their friction and power requirements.

Assuming the cost of power at two cents per kilowatt-hour, and that a working year contains 2,808 hours (54 hours per week), the cost of power for the foregoing installation would be $6 \times 2{,}808 \times \$0.02 = \$336.96$ per annum, of which 75 per cent., or $252.72 is chargeable to the line shaft. This assumption of power cost is low for many installations, especially for small, isolated plants.

While making the foregoing tests the machines were not all operating at full capacity. Assuming the best practical average operating conditions to be full capacity of each tool one-half of the time or one-half capacity full time, the machines would require 4 kw. The total average input to the motor would then be 8.5 kw., of which the line shaft would absorb 53 per cent. and the machine tools 47 per cent. The power costs at two cents per kilowatt-hour under the foregoing assumptions would then be $8.5 \times 2{,}808 \times \$0.02 = \$477.36$ per annum, of which 53 per cent., or $252.72, is chargeable to the line shaft.

Test No. 2. This test was made on a moderately loaded line shaft driving 5 machine tools. The details of the shaft construction were the same as in Test No. 1, and the other conditions were as follows:

Driving motor 30 h. p., 720 r. p. m.
Machine tools—

| | |
|---|---|
| One 14-ft. vertical boring mill; maximum power requirement | 3 kw. |
| One 5-ft. radial drill; maximum power requirement | 2 kw. |
| One 7-ft. radial drill; maximum power requirement | 2 kw. |
| Two No. 8 Niles horizontal boring, drilling and milling machines; maximum power requirement, each | 3 kw. |
| Maximum power requirement with all tools working at maximum capacity | 13 kw. |

The input to the motor, when driving the line shaft alone, was 3.5 kw. Tests of several hours' duration showed an average of 2.1 kw. additional to drive the tools under practical operating conditions. That is, the total average motor

*From The Electric Journal.

input was 5.6 kw., of which the line shafting absorbed 63 per cent. and the machines only 37 per cent.

The annual cost of power, at $0.02 per kilowatt-hour, would be 5.6×2,808×$0.02=$314.50, of which 63 per cent, or $196.56, is chargeable to line shafting and the remainder, $117.94, to the tools. The maximum input to the motor observed during the test was 6.6 kw.; but assuming, as before, a maximum average of one-half full capacity, the machines would require 6.5 kw., making a total average input of 10 kw., of which the line shaft would require 35 per cent. and the tools 65 per cent. The power cost, at 0.02 per kilowatt-hour, would then be 10×2,808×0.02= $561.60 per annum; 35 per cent., or $196.56, being chargeable to the line shaft, and 65 per cent., or $365.04, to the tools.

Test No. 3. This test was made on a heavily loaded line shaft driving 12 machine tools. The length of the line shaft was 300 feet, all other dimensions of the shaft, bearings and couplings being the same as in test No. 1. The driving motor was 40 horse-power, 720 r. p. m., and the tools consisted of three planers, five boring mills, three radial drills, one slotter and one milling machine.

The input to the motor for the shaft alone was 6.3 kw., and the average additional input for the machine tools was 8.0 kw., making a total average input of 14.3 kw. Of this total the shafting absorbed very nearly 44 per cent. and the tools the remainder, or 56 per cent. The annual cost of power, with the former assumptions, would be 14.3×2,808× 0.02=$803.09 of which 44 per cent., or $353.36, is chargeable to the shafting.

If all the tools driven from this line shaft were working simultaneously at full capacity they would require a motor input of 42 kw. The maximum input to the motor observed during the test was 19.4 kw. Assuming, however, maximum practical average operating conditions to be half capacity full time, the machines would require 21 kw., making a total input of 27.3 kw., 23 per cent. being chargeable to the line shaft. The power cost at $0.02 per killowatt-hour would then be 27.3×2,808×0.02=$1,533.17 per annum, of which $353.36 is chargeable to the line shaft.

### Economy In Time.

The relative time economy of motor drive and shaft drive is best illustrated by comparing the two methods for a given installation. The overhead charges, consisting of interest, insurance, taxes, repairs to plant, salaries, etc., are practically the same for either method of driving.

For purposes of comparison, the cost of equipping the tools referred to in Test No. 2 with individual motors will be considered, and the saving to be affected thereby estimated. The data used for making the comparison are based either on actual tests or assumptions warranted by experience.

TABLE II—MACHINE TOOLS AND OPERATING COSTS OF TEST NO. 2.

| Machine Tool | Operating Costs Overhead | Wages | HP | Indiv. Motors. Cost Including Controller |
|---|---|---|---|---|
| 14-ft. Vertical Boring Mill.... | $1.50 | $0.35 | 10 | $370 |
| 5-ft. Radial Drill..... | .50 | 0.30 | 5 | 255 |
| 7-ft. Radial Drill..... | 1.20 | 0.30 | 7.5 | 290 |
| No. 8 Horizontal Boring Mill.. | 3.00 | 0.35 | 5 | 200 |
| No. 8 Horizontal Boring Mill.. | 3.00 | 0.35 | 5 | 200 |
| Total Costs .... ..... | $9.20 | $1.65 | | $1,315 |

The overhead cost and wages per year of 2,808 hours (54 hours per week), for either line shaft or motor drive, from Table II, are:

| | |
|---|---|
| Overhead ..... 2,808 × 9.20 = | $25,833.60 |
| Wages ..... 2,808 × 1.65 = | 4,633.20 |
| Total ..... | $30,466.80 |

The cost of a large motor and line shaft drive for the foregoing installations is approximately $900. The cost of the individual motors is $1,315, as indicated in Table II. Assuming that the cost of attachments, changes in tools to fit them for motor drive, wiring, etc., is the same as the cost of line shaft drive, $900, the total cost of the individual motor installation is $1,315+$900=$2,215.

| Item. | Line Shaft Drive. | Individual Motor Drive. | Advantage of Individual Motor. |
|---|---|---|---|
| 1—Power consumption | Constant friction. Loss in shafts, belts and motor. Power for cutting. | Friction loss (motor and tool only) and useful power only while working | Less power required |
| 2—Speed control | No. speeds = No. cone pulleys × No. gear ratios. | No. speeds = No. controller points × No. gear ratios | More speeds possible. Time saved in making speed adjustments |
| 3—Reversing | Clutch and crossed belt. | Reversible controller | Time saved in reversing |
| 4—Adjusting tool and work | Stopping at any definite point very difficult | Can be started in either direction and stopped promptly at any point | Time saved in setting up and lining up a job |
| 5—Speed adjustment | Large speed increments between pulley steps | Small speed increments between controller steps | Time saved in obtaining proper cutting speed |
| 6—Size of cut | Limited by slipping belt Large belts hard to shift | Limited by strength of tool and size of motor | Time saved by taking heavier cuts |
| 7—Time to complete a job | | | Much less time required as indicated for previous items |
| 8—Liability to accidents | Slipping or breaking belts. Injury to machine tool, cutting tool or prime mover | Injury to machine tool, cutting tool or motor | Much less liability to accidents |
| 9—Checking economy of operations | Close supervision required. Very difficult to locate causes of delay | Accurate tests possible by means of graphic records | Causes of delay and the remedies easily located without personal supervision |
| 10—Flexibility of location | Location determined by shafting, and changes are difficult | Location determined by sequence of operations. Changes readily made. | Greater convenience in handling work and increased economy of operation. More compact arrangement possible |

TABLE I—COMPARISON OF LINE SHAFT DRIVE AND INDIVIDUAL MOTOR DRIVE.

The cost of power for line shaft drive, as determined from Test No. 2, is $314.50 per year, with power at two cents per kilowatt-hour, of which $117.94 is chargeable to the tools. In some cases the installation of individual motors has resulted in more than 20 per cent. increased output, but assuming a conservative estimate, ten per cent, the power cost can safely be placed at $130 per year. Calculating interest on the cost of the machine tool at six per cent. and depreciation at 10 per cent., the operating cost can be compared as follows:

| | Line Shaft. | Indiv. Motors. |
|---|---|---|
| Overhead and wages ..... | $30,466.80 | $30,466.80 |
| Interest and Depreciation @ 16% on costs of installation, $900 and $2,215, respectively ..... | 144.00 | 354.40 |
| Power ..... | 314.50 | 130.00 |
| Total ..... | $30,925.30 | $30,951.20 |

This comparison shows a balance in operating costs of $30,951.20—$30,925.30=$25.90, favoring the line shaft drive. Experience has shown, however, that tools equipped with individual motors will turn out at least ten per cent. more finished product than they will when line-shaft-driven. Assuming that the earnings of the shaft-driven tools are just equivalent to their operating costs, an increase of ten per

cent. in output makes $0.10×$30,925.30=$3,092.53 increased earnings per year obtainable by the use of individual motors with scarcely any increase in arrangement for driving a shop in any given case.

With the assumed maximum practical operating conditions given under Test No. 2, the power cost for line shaft drive is $561.60, $365.04 being chargeable to the tools. Assuming ten per cent. increased output with individual motor drive, the cost of power would be about $400. The comparison of line shaft drive and individual motor drive would then be as follows:

| | Line Shaft. | Indiv. Motors. |
|---|---|---|
| Overhead and wages | $30,466.80 | $30,466.80 |
| Interest and Depreciation @ 16% on costs of installation, $900 and $2,215, respectively | 144.00 | 354.40 |
| Power | 561.00 | 400.00 |
| Total | $31,172.40 | $31,221.20 |

This assumption leaves a balance of $48.80 favoring line shaft drive, provided the increased output with motors be not considered. When allowance is made for ten per cent. increased output, the comparison shows $3,117.24—$48.80=$3,068.44 per year favoring individual motor drive.

The foregoing analyses show that the only consideration favoring line shaft drive—namely, lower first cost—is much more than overbalanced by the increased production possible with motor drive; also, that the cost of power, though in favor of motor drive, plays a very small part in the determination of operating expenses in a machine shop. It is to be noted also that the higher the cost of power the more favorable the proposition becomes to individual motor drive.

The foregoing shows that the question of whether or not to use individual motor drive in any particular case is a financial one and must be properly analysed. The best way for a shop manager to solve this problem is to be guided by the following question: What investment shall I make and how shall I equip my shop so as to obtain the greatest income upon the invesment? Individual drive means an increase in investment, but in nearly all cases a much greater percentage income will be reaped than if line shaft drive was employed. The above discussion shows in a general way how to determine the best expense, leaving a net annual profit of approximately $3,092.53—$25.90=$3,066.63, favoring the motor drive.

## SAFETY IN TRAIN LIGHTING.

Train lighting is one of those specialized subjects that do not receive much attention in the technical world. This is rather to be expected, for the field of train illumination is so very much smaller than that of public electricity supply for light and power. Nevertheless the subject is important, and we may certainly say that to the traveling public it is very important indeed.

First, there is the question of adequate and steady illumination. Not so very many years ago railway traveling after dusk was a most monotonous procedure, as reading was only possible at considerable risk of damaging the eyesight. Since those days there has been a very marked change for the better, and passengers can now read with comparative comfort. There is, however, a further point which we wish to emphasize more particularly on the present occasion, namely, that of safety. In raising this question we have no wish to be in any sense alarmist. Considering the vast number of train miles run every year it will be admitted that railway traveling is now extraordinarily safe. Nevertheless, so long as the human element is present in railway working, accidents certainly will occur from time to time, and in such cases it is most important that the illuminant should be of such a character as not to give rise to fire. A railway accident in itself is bad enough, but the horror is increased tenfold if a fire occurs.

In this connection it can be said, without fear of contradiction, that electricity is very much ahead of its rivals, and that it is in fact the only safe illuminant. This point is being much more fully appreciated on the Continent than in this country. Thus, in a recent issue of the "Neue Freie Presse" of Vienna, it is pointed out that a number of railway accidents have taken place recently at Marburg, Herlishein, Trenton, Missouri, Uhresko, on the Canadian Pacific Railway and elsewhere, and that in such cases, as a sequel to the accident, the gas used for illumination has caused a fire to break out, thus sacrificing the lives of passengers who would otherwise have escaped. At a meeting of the Council of the Austrian State Railways recently the Ministry were requested to introduce a modern illuminant for lighting railway stock, and the representatives of the Administration informed the meeting that it was their intention to introduce incandescent gas lighting. At the next meeting this decision led Mr. Maxime Krassny to move the following resolution: "The Ministry for Railways is requested to discontinue the use of gas for lighting passenger trains, and to use exclusively electric lighting for all future passenger cars as well as for those at present on order."

In the discussion that ensued Dr. Ellenbergen mentioned that in Italy gas was being completely eliminated, even oil being used in preference. There were still approximately 1,400 cars lighted with gas on the Italian railways, but a portion of these were being converted to electric lighting and the others were to be converted in the near future. The representative of the Government, in replying, stated that the Administration were doing everything in their power to improve the lighting, having regard to the means at their disposal. A series of tests which had lately been completed showed that, taking into consideration recent improvements, electric train lighting possessed economical advantages. As a result of these tests they had decided not only to convert old cars to the electric system, but that the same system should be used for the new cars to be supplied in 1911, and if further results were in any way favorable to electric lighting the use of this system would be greatly extended in future. As a result of the discussion a resolution was adopted practically in the form moved by Mr. Krassny.

In all such matters, of course, the question of cost is of some importance, but where safety is concerned cost should not be permitted to have an undue influence. In the present case, however, there is not much to choose between the cost of running electric light and incandescent gas for train lighting. The introduction of the metal filament lamp has, naturally placed the electrical method at some further advantage, though it is rather in the improvement of the illumination than in the reduction of the running cost. In electric train lighting equipments the running cost is largely due to the initial outlay. The cost of producing the energy is negligible, and therefore it does not matter whether the lamps are efficient or inefficient. On the other hand, with metal filament lamps the battery can be smaller than would otherwise be the case, and consequently there is a gain in part of the equipment, and there is a marked advantage in the better illumination that can be given. In any case, the difference in cost between the two systems appears to be comparatively small, and therefore there is every reason for train lighting to be considered from the point of view of safety in this country as on the Continent, and that without delay. Questions involving the safety of the general public on railways come under the control of the Board of Trade, and considering the present position of the whole question, we do not think it would be out of place for the Board of Trade to take some action in the matter without waiting for a disaster, with its attendant sacrifice of human life, when public opinion will doubtless force such action to be taken.—*Editorial in The Electrician, London.*

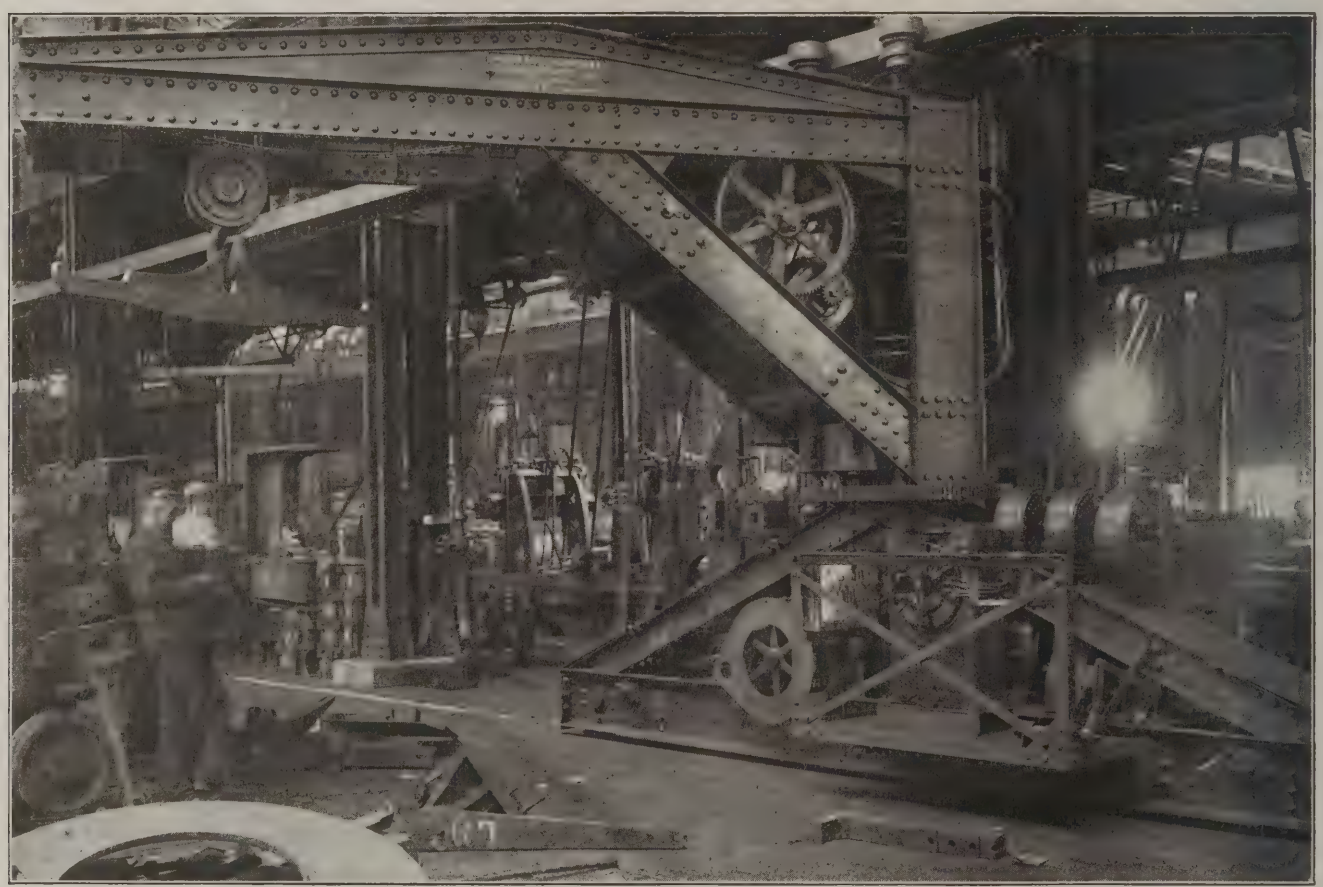
**CAR LIGHTING CLUB**
**WEDNESDAY, SEPTEMBER THE SEVENTH**

# Motor Drives in the Burnside Shops

## Interesting Uses of Electricity by The Illinois Central Railway

One of the handiest and most efficient pieces of machinery in the Burnside shops of the Illinois Central Railway is a small electrically operated jib crane used in the locomotive erecting room. This crane, which was built by the Whiting Foundry Co., has a hoisting capacity of 7 tons when operating with its full arm of 12 feet. It is used largely in moving locomotive wheels and other moderately heavy parts. The crane runs on a single steel rail set in concrete, being guided above by a heavy channel. Three Western Electric Co. entrims heavy castings to all sizes desired for use in the shop.

To carry the load of these machines and others lately installed there another 200 k. w., d. c. unit has recently been put in. This brings the total generating capacity of the power plant up to 400 k. w. Of this power only about 50 k. w. is used for lighting, the remainder going to operate motor driven machinery. It is significant that practically all the machinery installed at this plant during the last four years has been of the motor driven type.



The 7-Ton Jib Crane in the Illinois Central Burnside Shops.

closed motors are used in its operation. All are series wound operating at 220 volts D. C. The hoisting is done by a 15 h. p. motor, a 10 h. p. motor moves the crane along the track, while the jib is swung through a complete circle by a 2 h. p. motor.

Other motor driven machines which have recently been added to the equipment of these shops are a large Putnam lathe for trimming locomotive drive wheels and a forging machine for turning out small standard parts. The lathe is operated by a 50 h. p. Westinghouse motor with Westinghouse controllers and a small 7½ h. p. motor for moving the clutch which holds the wheels while they are being trimmed. With it the average time for cutting a pair of wheels to true dimensions has been reduced to about an hour and a half. The forging machine is fitted with standard dies which are pressed together on the hot steel to make forgings which were formerly pounded out by hand.

A 10 h. p. Interpole motor, built by the Northern Electric Co., is used in the operation of a Steinle Turret Lathe, which

### NEW ELECTRIC LOCOMOTIVES.

The Illinois Traction System is building six heavy electric locomotives at its shops in Decatur, Ill. They will be equipped with four General Electric, 600-h.p. motors with Sprague-General Electric, multiple unit type M control. The trucks will be furnished by the American Locomotive Company and the air brakes will be Westinghouse EL. The locomotives will resemble in general outline the steel turtleback cars in use on this line, and will be 34 ft. long, 9 ft. 3 in. wide. They are to be equipped with M. C. B. couplers and steel pilots.

### HEADLIGHTS ON STRAIGHT STORAGE SYSTEM.

The Pennsylvania Railroad is experimenting with electric headlights operated on the straight storage system. With these headlights the locomotive is wired so as to take current from the batteries on the cars of the train. The headlight can, therefore, be operated only when the train is coupled to the locomotive, and with passenger trains only.

# Shop and Power House Illumination

## A Field of Usefulness for The Cooper Hewitt Lamp

There are several methods of lighting railway machine shops in use today. They may be divided into general and individual systems. General systems are those in which large illuminating units are used to light several machines and cover a considerable area. Individual systems are those in which small units are used to light limited areas somewhat more intensely.

Illumination of the New York Central Power Plant with Cooper Hewitt Lamps.

A combination of the two methods is frequently used. The individual system is seldom used alone, the small lights being usually reinforced by several arcs or other large units.

Four different types of large units are in general use. They are: The carbon arc, the flaming arc, the tungsten cluster and the Cooper Hewitt lamp. It is the purpose of this paper to deal with only one of these units—the Cooper Hewitt lamp. No attempt will be made to compare it with the other units in point of economy of current consumption. Some idea as to this can be gained from the results of a test which are published elsewhere in these columns. In other respects any discussion of a lighting unit must necessarily be somewhat of a comparative nature, as it is by comparison that it must be judged.

The Cooper Hewitt lamp has been on the market for about six years now and its widespread use shows that it must have high merit. The writer recalls first having seen the lamps at the St. Louis exposition in 1904, where, on the high steel tower of the De Forest Wireless Telegraph Company, their peculiar greenish light was visible over nearly the whole exposition grounds. In principle it was different from any electrical illuminating device then in use, though others similar have since been developed.

The ordinary electric lamp gives out light from a filament of some material which is rendered white hot by the passage of an electric current, and is prevented from oxidizing by being enclosed in a glass globe from which the air has been exhausted. In this type of lamp from 90 to 95 per cent of the energy is used up in the form of heat, while from 5 to 10 per cent only is available as light. The Cooper Hewitt lamp gives out light from mercury which is changed to vapor and rendered incandescent by the passage of the electric current. In this lamp 60 to 65 per cent of the energy is dissipated as heat, while 35 to 40 per cent is available as light. This one fact would explain a considerable difference in lighting efficiency between the Cooper Hewitt and the ordinary filament lamp.

The standard size Cooper Hewitt is a glass tube 30 inches long by an inch and a half in diameter, containing a small amount of mercury. The air is exhausted from the tube while terminals are sealed into the ends. The passage of an electric current through the mercury causes it to be vaporized, and the vapor to become incandescent, with the result that it gives out a mild but very penetrating light of a greenish tinge. The peculiar color is due to the absence of red rays. As these rays are non-actinic on the photographic plate the light is excellently adapted for photographic work, and in this way has become familiar to every one through its use in the picture-while-you-wait studios.

Although scarcely well fitted for office illumination on account of the fact that it imparts a ghastly pallor to the most finished complexion, it is nevertheless an excellent light for drafting rooms, and printing establishments where there are many fine details for the eye to grasp. The Bureau of Engraving at Washington uses these lamps day and night in printing and engraving U. S. paper currency, and finds this system more satisfactory than the use of sunlight by day and artificial near-sunlight at night.

Of all the uses to which it has been put the illumination of machine shops seems to be the one to which it is best adapted. The points in its favor for this purpose are the freedom from glare, not only from the light itself, but also from the reflection from metal surfaces, its excellent diffusion, and its low cost of maintenance in having no carbons to be renewed or other necessary attendance.

The absence of glare is explained by the large illuminating surface (over 150 square inches with a 30-inch tube) as compared with that of an arc which is almost a point. The lamp has a low intrinsic brilliancy. The freedom from reflected glare is accounted for by the non-occurrence of the red rays, which are said to be those most reflected.

Another reason why the Cooper Hewitt lamp should show a higher lighting efficiency than the ordinary incandescent is that the luminous matter is transparent, or at least translucent, so that light produced in the center of the tube can escape and be of some use outside it. In the case of metal or carbon at white heat, only the surface is capable of radiation.

The excellence of the Cooper Hewitt lamp as a shop illuminant is best shown by the fact that it is now installed in the shops of the C. & N. W., C. & A., Big 4, Grand Trunk and St. L. & S. F. railways, while there are many others in which it is being tried. It is also being used in the Chicago freight houses of the Wabash and Rock Island, and in the auditing department offices of the latter.

The lamp is by no means a universal illuminant. There are many purposes for which it is not at all fitted. For the lighting of homes, offices and stores it can probably never compete successfully with the tungsten and tantalum filaments, and especially with the indirect lighting systems employing these units, but for shop lighting it does, indeed, seem to be *the* lamp.

Illumination of a Locomotive Shop.

# Test of an Electric Head Lighting Set

## PROF. H. G. SCHMIDT

This test was made by Professor Schmidt in the laboratories of the University of Illinois upon a Premier Electric Headlight equipment furnished by the R. G. Peters Manufacturing Co. of Grand Rapids, Mich. It is hoped that the results obtained will throw some light on the much vexed question of electric headlighting. Tests of this sort, made by independent and impartial authorities, do more than anything else to clear up disputed points about electrical equipment and put the apparatus of competing manufacturers on the basis of merits rather than claims.

**The Apparatus Tested.**—The apparatus submitted consisted of a turbine generator designed to furnish current for an electric headlight for locomotives, and an electric arc lamp.

When adjusted to work in connection with a two-carbon arc lamp the normal speed of the turbine generator is 3,500 revolutions per minute, at which speed the generator is designed to furnish current at 30 volts. The generator has a rated normal capacity of 30 amperes and a rated maximum capacity of 45 amperes.

The arc lamp designated as a two-carbon lamp has two carbon electrodes, both of which are operated by the feeding mechanism.

**Purpose of the Tests.**—The general purposes of the tests and the examination were: To determine the steam consumption of the turbine-generator under various steam pressures, and to determine the candle-power of the arc lamp.

**Tests to Determine Steam Consumption.**—The first series of tests was run with the turbine and generator under the same conditions of steam pressure and load as would prevail in service. In this series the load consisted of the two-carbon arc lamp and five 8-candle-power incandescent lamps. The latter, in service, are used as cab lights. Among others, two different nozzles, having throat diameters of 3-16 inch and 7-32 inch were used in the turbine in this series.

| Number Test | Throat Diameter of Nozzle | Pressure of steam supplied | Lamps or Rheostat | Duration of test | Average Speed | Quality of steam supplied | Generator output | Weight of Dry Steam used per Kilowatt Hour | Weight of Dry Steam used Power Hour per Horse- |
|---|---|---|---|---|---|---|---|---|---|
| | Inches | lbs.gage | Load* | Hours | R.P.M. | Percent | Kilowatts | Lbs. | Lbs. |
| 1 | 3/16 | 124.5 | L | 4 | 3312 | 97.5 | 0.947 | 225 | 168 |
| 2 | 3/16 | 150.8 | L | 3 | 3476 | 97.7 | 1.032 | 225 | 168 |
| 9 | 3/16 | 150.8 | R | 3 | 3237 | 96.3 | 0.961 | 222 | 166 |
| 13 | 3/16 | 175.0 | R | 1 | 3223 | 98.2 | 1.026 | 225 | 168 |
| 4 | 7/32 | 99.5 | L | 3 | 3070 | 97.4 | 0.832 | 257 | 192 |
| 12 | 7/32 | 199.8 | R | 1 | 3274 | 97.8 | 1.226 | 250 | 186 |

Test 12 is the overload test.
All tests run under atmospheric exhaust pressure.
*L means two-carbon lamp load; R means rheostat load.

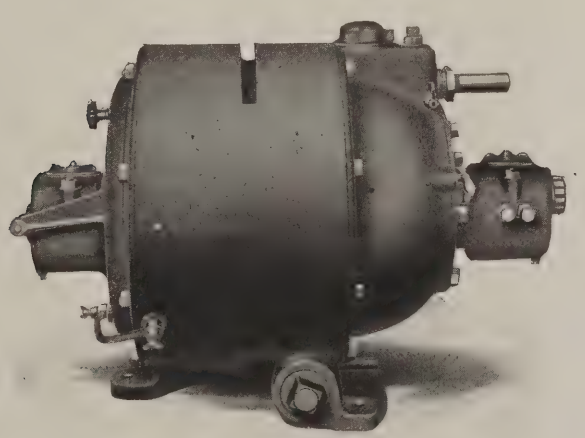
A second series of efficiency tests was run primarily to check the results of the first. In the second series, the current generated was absorbed in a water rheostat whereby a somewhat more uniform load could be maintained than was possible during the first series. The same combinations of nozzle and steam pressure were used during the second series as during the first; and the second series included also a test of one hour's duration to determine the action of the generator under a 50 per cent overload.

After three hours' run at normal load the overload test, lasting one hour, was made; and during this test the average current was 45.55 amperes at 26.92 volts, which imposed upon the generator a load approximately fifty per cent in excess of the usual operating load. At the conclusion of this test the maximum temperature of 91 degrees Centigrade was found to be in the armature coils.

**Power Speed Tests.**—With the 3-16 in. nozzle in the turbine and working under a nozzle chamber pressure of 120 pounds, tests were made to determine the relation between the power developed and the speed of operation. This is approximately the same nozzle chamber pressure as prevails during service conditions with the 3-16 in. nozzle in the turbine. At the normal service speed of about 3,400 R. P. M., the power developed was 1.00 kilowatt. The unit developed its maximum power (1.095 kilowatts) at a speed of 3,900 revolutions per minute. The power developed at normal speed is therefore, 91.3 per cent of the maximum power obtainable by operating at 3,900 revolutions per minute, the same quantity of steam being used as at normal speed. Such a test serves as a check upon the design of the whole unit. The results indicate that the design of both the turbine and the generator has been successful in meeting the conditions of speed and steam pressure which must have been originally imposed as its basis. Assuming that the 3-16 in. nozzle must operate under a steam pressure as low as 120 pounds, and assuming further that the design of the generator, the buckets, and the guide vances, and the speed of 3,400 revolutions per minute remain unchanged, it is possible that a slight increase in bucket speed (an increase in diameter of the rotor) might result in a slight increase in the efficiency of the unit.

**Leakage Test.**—A test to determine the amount of steam which leaks past the turbine governor-valve and the stem of the emergency valve was run under constant steam pressure of 175 pounds per square inch in the steam supply. During this test the entrance to the nozzle was closed by a blank flange and gasket; and the steam pressure in the nozzle chamber was therefore the same as in the supply line. The pressure in the exhaust chamber was maintained at that of the atmosphere. The test was continued one hour, during which time the leakage amounted to 23.5 pounds; which constitutes about ten per cent of the total steam consumed by the turbine when equipped with the 3-16 in. nozzle.

**The Candle-power of the Unreflected Lights.**—The lamp was tested to determine the variations in intensity of its unreflected light at different points in a plane passing through the axes of the two electrodes. Three sets of readings were taken with the photometer at distances of 20, 25 and 35 feet respectively from the arc.



The Turbo-Generator Used in this Test.

During the first series of the efficiency tests of the turbine-generator, the average load was about 30 amperes at 30 volts. Of this current the five incandescent lamps in the circuit consumed 4 amperes, leaving as the operating current for the two-carbon arc lamp itself 26 amperes. This lamp was, therefore, tested under a current of 26 amperes at 30 volts, which is its power input when in service.

The maximum intensity of the unreflected light occurred along a line 30 degrees above the horizontal plane, in which direction it was 1,720 candle-power. The curves of distribution are shown in the accompanying diagram.

**Tests of the Reflected Light.**—The lamp was also tested in a locomotive headlight reflector which had been in regular service. This reflector had a maximum diameter of 18 inches and a depth of 8⅞ inches. Determination of the intensity of the light is the reflected beam were made at a distance of 100 feet from the arc. At this distance the intensity of the light in a plane at right angles to the axis of the beam varied from 20 foot-candles at the axis to 6 foot-candles at a distance of 4½ feet from the axis. Over an area in the center of the beam 3 feet in diameter the intensity of 20 foot-candles was practically uniform.

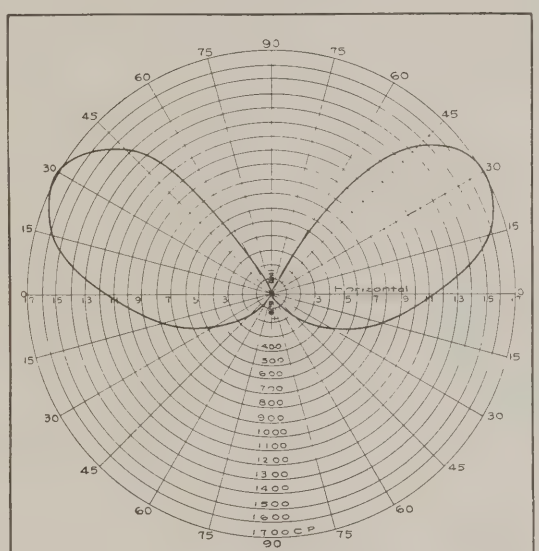



FIGURE 13

DISTRIBUTION OF LIGHT IN THE VERTICAL PLANES FOR THE TWO-CARBON ARC LAMP UNDER A CURRENT OF 26 AMPERES AT 30 VOLTS

THE CIRCLES REPRESENT CANDLE-POWER VALUES.

While any expression of these results in terms of candle-power is apt to be misleading, it may be stated that the illumination in this central core of the beam is of such an intensity that to equal it with an unreflected light which radiates equally in all directions the latter would need to be of 200,000 candle-power. This is of course in no sense the candle-power of the reflected light.

## SOUTHERN PACIFIC SHOP KINK.

Mr. O. L. Brainard, a veteran axle light inspector on the lines of the Southern Pacific Company at Los Angeles, has devised a neat "kink" for use with battery covers. It consists of a lead casting turned up quickly in a lathe, and used instead of the rubber vent plug. The weight of the plug keeps it down firmly on the cover, preventing sloppage, and in warm climates where evaporation is rapid the ease with which it can be removed for the renewal of distilled water, particularly where rubber gloves are used, makes it of some advantage so far as time is concerned as compared with unscrewing a rubber plug.

# Three Methods of Shop Lighting*

## A Comparison of Nernst, Cooper Hewitt, and Tungsten Lamps

The problem in this case was a typical modern machine and erecting shop, the building being 572 ft. long and 310 ft. 6 in. wide, and divided lengthwise into five aisles. One of these aisles was divided into three sections, which were lighted by Nernst, Cooper Hewitt and tungsten lamps, respectively. The ground plan, showing the arrangement of these aisles and of the different lighting systems installed is shown in Fig. 1.

The method of making the illuminometer readings is as follows:

A test section was taken in the center of each group of lamps, and in this section twenty stations were located, as shown in the diagram, at which the illuminometer readings were made. In comparing the results it should be noted that the section in which the tests of the Cooper Hewitt lamp was made was subjected to errors due to shadows caused by two large slotting machines. At station 13 in this section the light of the lamp directly overhead was practically cut off by one of these machines. Stations 17, 18 and 19 had each the direct light of four lamps cut off, and station 20 that of five lamps. Stations 17, 18, 19 and 20, under the Nernst lamp group, were also slightly shadowed by a radial drill.

Readings at the different stations in the three different test sections are shown in Table II.

A summary of the various data contained is shown in Table I.

Eleven Cooper Hewitt lamps had been in service about two years, during which time three tubes had been renewed. The Nernst and Tungsten lamps had been in service three weeks, burning approximately 10 hours a day, six days per week. Ten of the twelve lamps were equipped with clear globes and two with opalescent globes; all were equipped with opalescent enameled reflectors. The 250-watt Tungsten lamps all had clear bulbs and were equipped with focusing type prismatic reflectors. As the Nernst and Tungsten installations have only been in three weeks, it is impossible at present to compare the maintenance costs.

TABLE NO. I.

Class of work: Large machine tools.

Dimensions of aisle: 65 x 572 ft. Area: 37,180 sq. ft.
Number of bays, 26; each 22 ft. wide.

| | | Cooper Hewitt. Lamps, Type P. | Nernst Lamps, 3 Glower. | Tungsten Lamps, 250-Watt. |
|---|---|---|---|---|
| Height to center of trusses | ..... | 37 ft. 6 in. | 37 ft. 6 in. | 37 ft. 6 in. |
| Height of lamps | ..... | 36 ft. | 36 ft. | 36 ft. |
| Height of test plane | ..... | 2 ft. 6 in. | 2 ft. 6 in. | 2 ft. 6.in. |
| Height of lamps above test plane | ..... | 33 ft. 6 in. | 33 ft. 6 in. | 33 ft. 6 in. |
| Number of lamps | ..... | 11 | 12 | 12 |
| Square feet illuminated per group | ..... | 15,730 | 12,870 | 8,580 |
| Number of lamps per bay | ..... | 1 | 1½ | 2 |
| Square feet illuminated per bay | ..... | 1,430 | 1,430 | 1,430 |
| Average voltage | ..... | 113 | 237 | 115 |
| Average current amperes per lamp | ..... | 3.5 | 1.75 | 2.07 |
| Average watts per lamp | ..... | 395 | 415 | 238 |
| Average square feet per lamp | ..... | 1,430 | 1,073 | 715 |
| Average watts per bay | ..... | 395 | 622 | 476 |
| Number test stations per group | ..... | 20 | 20 | 20 |
| Watts per square foot | ..... | .276 | .387 | .333 |
| Square feet per watt | ..... | 3.62 | 2.59 | 3.00 |
| Average foot candles | ..... | 1.20 | .928 | .896 |
| Foot candles per watt per square foot | ..... | 4.35 | 2.40 | 2.69 |
| Lumens | ..... | 18,876 | 11,943 | 7,688 |
| Lumens per watt | ..... | 4.35 | 2.4 | 2.7 |
| Watts per lumen | ..... | .23 | .42 | .37 |

TABLE NO. II.

Foot Candle Readings of 60 Stations, 20 to Each Group of Lamps.

| Test Stations. | Cooper-Hewitt, Type P. | Nernst Lamps, 3-Glower. | Tungsten Lamps, 250-Watt. |
|---|---|---|---|
| 1 | 1.5 | 1.22 | 1.2 |
| 2 | 1.55 | 1.23 | 1.2 |
| 3 | 1.58 | 1.28 | 1.2 |
| 4 | 1.60 | 1.25 | 1.21 |
| 5 | 1.41 | 1.13 | 1.05 |
| 6 | 1.64 | 1.1 | 1.14 |
| 7 | 1.50 | 1.14 | 1.08 |
| 8 | 1.58 | 1.15 | .94 |
| 9 | 1.40 | .96 | .83 |
| 10 | 1.11 | .97 | .92 |
| 11 | 1.43 | .93 | .99 |
| 12 | 1.15 | .91 | .98 |
| 13 | .82 | .73 | .835 |
| 14 | 1.00 | .70 | .79 |
| 15 | .97 | .71 | .76 |
| 16 | 1.14 | .74 | .71 |
| 17 | .70 | .62 | .49 |
| 18 | .67 | .62 | .505 |
| 19 | .68 | .59 | .53 |
| 20 | .565 | .58 | .57 |
| Average | 1.20 | .928 | .896 |

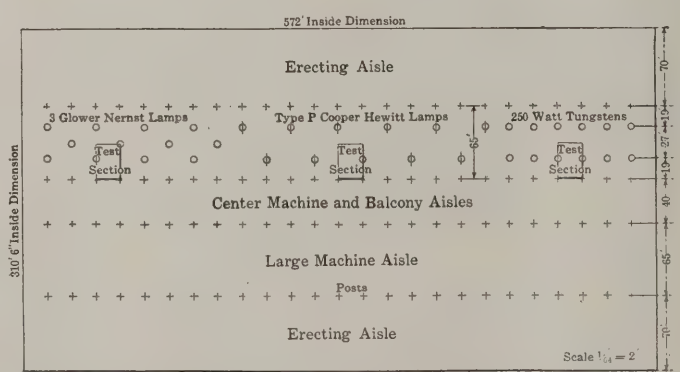



Fig. 1. Showing the Arrangement of the Lighting Systems.

*The Illuminating Engineer.

# FREIGHT SHED TRAVERSING CRANE

An interesting application of electricity to railway operations is reported in the London *Railway Times*. Additional facilities for handling goods in the Newton shed of the Great Western Railway at Cardiff having become necessary, it was proposed to supply ten stationary cranes. But after consideration had been given to the matter by the company's electrical engineer and traffic manager, one overhead electric traversing crane was selected instead.

The crane travels on a gantry carried by the columns supporting the goods shed roof, a special feature being the use of an inverted jib suspended from the traveling crane and working on the underside of the main crane girders. The crane has a range over two platorms, each 315 ft. long, and three sidings, capable of holding in all 46 wagons, and it is possible for traffic to be deposited in, or picked up from, any of the wagons. It has also a range over 45 drays standing alongside the platform.

Electric Traversing Crane for Handling Freight at Cardiff, England.

In the design of the crane there have been combined the advantages of an ordinary slewing, traveling and hoisting jib crane with an overhead traveling crane. On each side of the shed, fixed to the columns, is a gantry on which the end carriages of the cross girders of the crane travel. These girders are of the lattice braced type, built up of rolled steel sections, so as to obtain the maximum strength with the minimum amount of weight. The lower member of the braced girders forms a runway for the traveling crab, from the underside of which is suspended the jib crane. This crane is capable of performing four motions, each of which is individually controlled, viz., hoisting at 30 ft. per minute, slewing 2 revolutions per minute, cross-traversing at 120 ft. per minute, longitudinal traveling 250 ft. per minute.

Each motion is performed by means of an independent motor and controller, the controllers for hoisting and slewing being fitted with a combined handle so that the movement of the handle corresponds to the movement of the load in either direction. The cross traversing and longitudinal traveling are operated by means of independent controllers. The motors for the various motions of the crane are of the totally-enclosed type, series wound, and are amply proportioned for the work they have to perform. They are capable of withstanding a heavy overload without excessive heating, or risk of damage to the insulation.

The hoisting controlled is fitted with rheostatic braking which enables the driver to regulate the lowering of the load by movement of the controller handle, the load being finally brought to rest by bringing the controller to the "off" position, therey applying the magnetic brake. In addition, a powerful hand brake, operated by means of a foot pedal, is provided on the hoisting motion to be used in case of emergency. All motions of the crane are fitted with automatic brakes, so that in case of failure of the current the crane is brought to a standstill.

To avoid the risk of the driver overhauling the load, an automatic overwinding device is provided so that when the load is raised to a predetermined height, the current is cut off and the magnetic brake applied. The longitudinal travelling motion of the crane is also provided with automatic cutouts so that when the crane reaches a predetermined point on the longitudinal gantry, the current is shut off and the crane stopped by the magnetic brake.

The center column of the jib crane is of special steel, machined all over, and hollow, the weight of the crane being carried on ball bearings fitted to the head of the column. This column is designed with a large diameter and a very high factor of safety, the cables for carrying the current to the various parts of the crane being led through the center of the column.

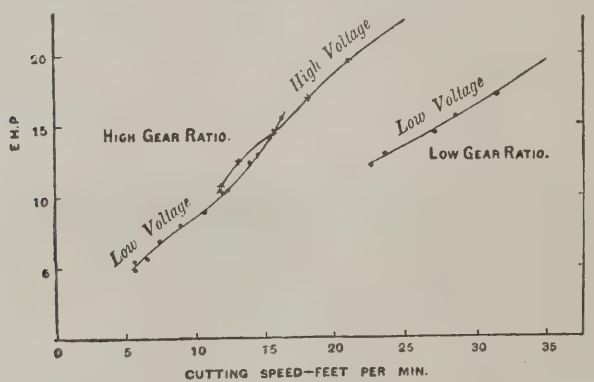
In the construction of the machinery steel has been used as far as possible. The pinions were cut from mild steel blanks and the shafts made from wrought steel. The hoisting barrel is of cast iron, machined, and suitably groved for the rope, which is made from strands of the best quality plough steel, and has a high factor of safety. The hook is fitted with ball bearings.

The crane was designed for a working load of 2,000 pounds but was tested with loads of 2,500 pounds in all directions. It is understood to be proving highly satisfactory.

## HIGH-SPEED TOOLS.

At the Birmingham meeting of the Institution of Mechanical Engineers, Mr. H. I. Brackenbury read an interesting paper on the use of high-speed tool steel, which indirectly emphasized the importance of the electrical drive in this connection.

Where full use is made of modern machinery with high-speed steel tools, the production, so far as roughing-out is concerned, is three times what it was under the old conditions. This means that the machines, the space occupied, the operators, shafting and supervision are all reduced in a like ratio, and although the power required to drive the machines is very large, the energy absorbed per lb. of metal removed is less than with low-speed machines.




INEFFICIENCY OF HIGH GEAR RATIO.

Many of the old English-made machines are quite heavy enough to be used with high-speed steel, with slight modifications. The driving power must be increased in a ratio generally in the neighborhood of 1:3 or 1:5; but in some cases, lathes formerly taking about 5 h.p. have been run up to 50 or 60 h.p., and a milling machine capable of removing 1,400 lbs. of steel per hour consumes no less than 92 h.p.

The stepped cone is becoming obsolete, speed changes being effected by means of sliding gears in medium-sized machines, and variable-speed motors in the larger sizes. Such motors, on a D. C. three-wire system, give a wide range of speed, but the author points out that at certain speeds with light cuts the efficiency of the motor and machine may be far from good. This is exemplified by tests of a large lathe cutting 0.2 x 0.2 in. on 40-ton tensile steel, as illustrated herewith; there is a drop in efficiency on changing from a low gear ratio to high voltage with high gear, so that the same power was consumed when cutting at 18 and at 33 ft. per minute. The motor was rated at 40 h.p. on the high voltage, and was therefore underloaded, the cut being a light one. The inference is that heavy lathes which have to do both light and heavy turning should have the gear ratio arranged so that the full range of speed can be obtained on either voltage, and the builders should give the total efficiency of the lathe and motor at various speeds and loads. The facility with which the efficiency can be determined when the electric drive is used is well illustrated in this example, and in an instance described by the author, in which the defects of gearing temporarily repaired were conspicuously revealed by an ammeter.

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## CHICAGO & NORTHWESTERN CHICAGO RIVER DRAW BRIDGE.

When it was built, the Chicago & Northwestern Chicago river draw bridge was the largest single leaf lift bridge in the world. Whether it still retains this distinction is doubtful, but there are few bridges of any description doing heavier duty than this old reliable. Fifteen hundred trains a day pass over it entering and leaving the Northwestern Wells Street station. It is the link which joins the vast west side yards to the lake front shipping docks and transfer yards.

On account of the fact that the station platforms are set at low grade to permit ready transfer from this track level to the docks, the floor of the bridge is close to the river. This condition accounts for the many daily openings required, as every tug, and in fact every launch with a canvas top, must have the bridge raised in order to pass.

During the summer months the bridge is opened on the average about 35 times a day. Careful records kept of the time of opening and closing show that the average time of each opening is about 2½ minutes. Thus traffic is cut off about 1½ hours out of the 24, not a very serious loss of time apparently, until the fact that nearly all of these openings take place in the day time during the hours of heavy traffic. One of the distinct advantages of the new station now being built west of the river is that drawbridge delays will be avoided.

The bridge span is 170 feet. The weight of steel in the span structure is 2,880,000 pounds. This is counterbalanced by a concrete block weighing 2,220,000 pounds, the center of gravity of which is set about 30 feet from the swing point.

Two series wound motors of 250 h.p. each are used to lift the bridge and lower it. These are installed in the small house on top of the structure, and are controlled from a station located on the side near the swing point. They take current at 220 volts from the Edison Company industrial service wires, the average lift load current being about 100 amperes.

The C. & N. W. Chicago River Draw Bridge.

The large surface exposed by the bridge structure (the top beams are nearly 3 feet wide) makes it a great accumulator of sleet and ice in the winter. This, combined with the moisture absorbed by the wooden floor causes a difference in weight of nearly 30 tons between winter and summer. Provision for altering the counter weight to take care of this has been made by sinking four wells in the concrete to be filled with pig iron in the winter.

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## PROGRESS OF ELECTRIFICATION IN SWEDEN.

Reports of the progress of electrification in foreign countries are increasing. While we in America are timorously approaching the issue and are hesitating at the initial step, up in Lapland, within the Arctic circle, the Swedish government is pushing ahead with its far-reaching plans for electrifying the complete State Railway system.

The government controls water rights representing a minimum output of 70,000 horsepower. When developed in conjunction with regulation of the lakes in the Great Lule River, this will be increased to about 300,000 horsepower. The government proposes establishing a hydro-electric plant at the present time of two generating units of 12,500 horsepower capacity each to supply the energy for propelling the trains. In addition, there will be a reserve unit of the same capacity and two 12,500 horsepower units for furnishing power for industrial purposes.—Electric Trunk Line Age.

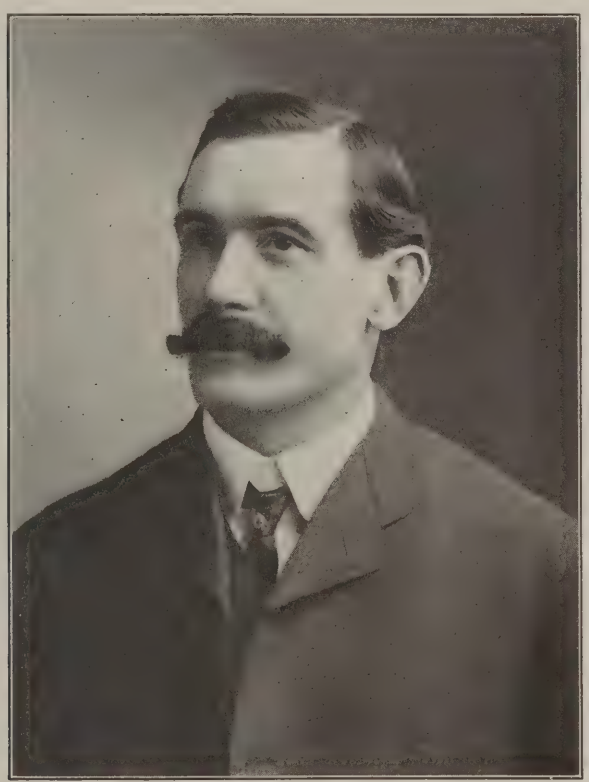
# General News and Personal Mention

## News Notes of General and Personal Interest to Car Lighting

## MEN AND MANUFACTURERS

### GEO. W. MURRAY.

Mr. Geo. W. Murray entered the train lighting field in 1894, when he became train electrician for the Pullman Company on the Florida Special running between New York and St. Augustine. He held this position during the winter season for five years, being employed during the summer months by the American Railway Electric Lighting Company of New York.



Geo. W. Murray.

In 1899 he entered the regular service of the latter company and stayed with them until some time after the reorganization which resulted in the present Consolidated Railway Electric Lighting and Equipment Company.

The Pullman Company regained the services of Mr. Murray in August, 1905, in their shops at Pullman, Ill. Early in 1906 he decided to go to southern California, and in May of that year he became chief electrician on the San Pedro, Los Angeles and Salt Lake Ry., the position which he holds today.

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Ten new 25 K. W. head end generating sets are being installed on the Baltimore & Ohio.

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Mr. F. P. Sherbondy, for seven years chief electrician of the C. R. & I. Ry., has resigned his position for one in the electrical department of S. F. Bowser & Co., at Fort Wayne, Ind.

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### HOLOPHANE GLOBES ON PULLMANS.

The Pullman Company has recently placed orders for 1,500 shallow Holophane miniature hemispheres No. 303. These reflectors will be used for berth lighting by the Pullman Co.

### DAVID W. PYE HEADS U. S. COMPANY.

David W. Pye, just elected President and a Director of the United States Light & Heating Company, began his career in the newspaper world and in 1889 joined with Col. A. W. Soper, President and organizer of the Safety Car Heating & Lighting Company. He was elected successively to the office of Purchasing Agent, Asst. to the President, 2nd Vice-president and Vice-president while with that concern. In his new position he has as associates on the Board of Directors, Messrs. Edwin Hawley, Jules E. French, Chas. A. Starbuck, Newman Erb and Theodore P. Shonts.

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Mr. Frank Koester of New York, in an important paper presented before the recent convention of the Society for the promotion of Engineering Education, held at Madison, Wisconsin, discussed in detail the educational system of the German technical universities. He also analyzed the conditions and standing of the German engineer as compared with our own.

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The Safety Car Heating & Lighting Company announces the appointment of Mr. John J. Mallay as their General Purchasing and Supply Agent. Mr. Mallay will have charge of all departments heretofore under the management of Mr. D. W. Pye.

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### NEW WESTERN ELECTRIC HEADQUARTERS IN MILWAUKEE.

The new Western Electric headquarters in Milwaukee was formally opened on July 28th. The store, which is located at No. 378 East Water Street, is one of the finest equipped electrical supply stores in Milwaukee. It is in charge of Mr. A. C. Keene.

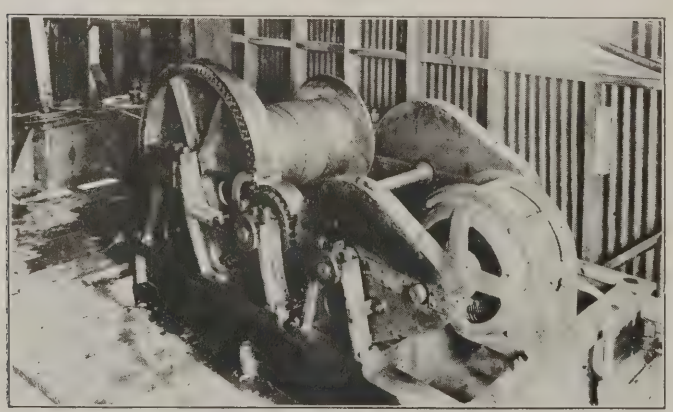
The accompanying illustration shows the exterior of the new store, which is a four-story and basement building devoted exclusively to displaying and storing telephone and power apparatus and electrical supplies of every description. The growth of business in Milwaukee led to the establishment of the fine new quarters.

## EXCAVATION BY ELECTRICITY.

Common as is the use of electric power for various purposes in the stationary, or staple industries, it still strikes one as rather remarkable that it should be used in construction work such as that of digging a canal. But it is being used for that very purpose on the Champlain Barge canal.

Electric Excavator on the Champlain Barge Canal.

Fig. 1 gives an exterior view of the excavating hoist in action. Fig. 2 shows the arrangement of the motor and hoisting drum. The motor used is 24 h.p., 3 phase alternating current being supplied to it at 550 volts pressure and a frequency of 40 cycles per second. The entire hoist occupies a floor space only 4½ feet square, and weighs 4,700



Motor and Hoisting Drum.

pounds. The friction drum measures 14 inches in diameter and has a base of 27 inches. The hoisting rope speed is 175 feet per minute, and the capacity of the hoist for a single rope is 3,000 pounds. The speed reduction is secured by the use of cut steel gears. The armature speed is made as low as possible in order to reduce the gear speeds, minimize wear, and obtain smooth running.

## LONDON SUBWAY CAR LIGHTING.

A combination of direct and indirect illumination is being used with very good effect in cars of the Waterloo and City Railway of London. This is a "tube" or subway line where illumination is obviously important. The lights are placed in the center of the car roof instead of along the sides. They are enclosed in opalite globes, which throw a considerable volume of light onto the white enameled ceiling which, owing to its peculiar shape, acts as a very efficient reflector. Seven 55 watt lamps serve to illuminate a large car. It is stated that some of these lamps have been in service for over a year and that the cars are well lighted with fewer lamps than are used in any other tube railway cars in London.

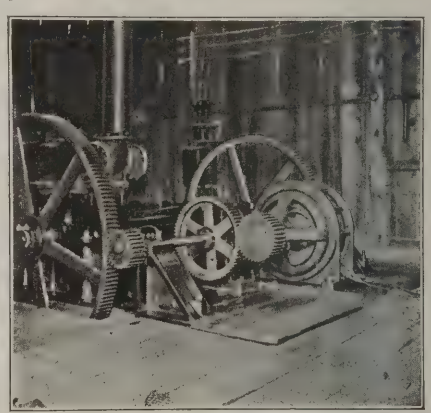
## WESTERN ELECTRIC DOES BIG BUSINESS.

Gross sales of Western Electric Company, New York, for the eight months to Aug. 1, ran at the rate of $61,000,000 per annum, which is an increase of 48 per cent over the same period of the 1909 fiscal year. July sales increased somewhat, showing a 50 per cent increase over July a year ago. This company now has 23,000 employes on its payrolls, an increase of 3,000 in the last four months, and compares with 17,000 last fall. The addition to working forces in the last few months has been necessitated largely by the increasing use of telephone apparatus in train dispatching.

## THE USE OF RAWHIDE PINIONS ON VIBRATING METAL-TO-METAL GEAR DRIVES.

Rawhide pinions are usually considered merely as a means of stopping noise on medium and high speed drives and by far the greater number of them are used for that purpose. It is a matter of engineering experience, however, that rawhide is quite beneficial on gear drives where there is vibration from irregular load or other causes.

This is well illustrated in the instance of the 1750-gallon quintuplex pump in the power plant of the Parral Power & Reduction Co., Parral, Chihuahua, Mexico. This pump as shown in the illustration is geared through double reduction to an induction motor and furnishes the circulating water for the condenser.



Originally this pump was driven entirely by cut steel pinions and cast iron gears. The pump was of so light a pattern that there was considerable spring in both shaft and frames. The result was constant annoyance from broken gear teeth, and in addition to gear renewals there was quite an expense due to the power loss of running the engines non-condensing while pump repairs were being made. The chief engineer had about decided to abandon the pump and replace it with another of different design when some one suggested the use of rawhide pinions. Accordingly four New Process pinions made by the New Process Rawhide Co. of Syracuse, N. Y., were substituted for the four steel pinions. Two of these are shown in the photograph, one on the motor and the other meshing with the big gear at the left. The other two are on the other side of the motor and placed symmetrically to those shown. These rawhide pinions were put into service over two years ago and there has not been a moment's trouble with the gearing since. In fact the pump has been out of service only long enough to repack the plungers and replace the rubber valves.

Rawhide where properly cured and machined makes up into a gear or pinion that is much the same as metal, except that it has no metallic ring and is more elastic. This elasticity is highly advantageous on motor drives in that it absorbs the shock as large gear teeth come into contact and as cutting tools come into cutting contact, and it cushions the irregularity of load due to the reciprocating movement of parts in machine tools or geared power plant apparatus.

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# Recent Patents Relating to Car Lighting

## A Review of the Patents Relating to Car Lighting and Allied Subjects Granted

## SINCE OUR LAST ISSUE

### 967,133. SYSTEM OF MOTOR CONTROL.

Samuel H. Keefer, Plainfield, N. J., assignor to Niles-Bement-Pond Company, Jersey City, N. J. Filed Nov. 8, 1909. An electro-magnetically actuated reversing switch is provided with a blow-out magnet and a pilot switch for preventing operation of the reversing switch until the counter electromotive force of the motor falls to a low value.

### 967,186. CONTROL SYSTEM FOR ELECTROMAGNETS.

Jay H. Hall, Cleveland, Ohio, assignor to The Electric Controller and Manufacturing Company, Cleveland, Ohio. Filed May 13, 1910. These are connections constructed and arranged to cause energizing currents to flow successively through the winding in opposite directions and to interrupt the second energizing current when it reaches a predetermined value.

### 967,295. BRAKING ALTERNATING-CURRENT MOTORS.

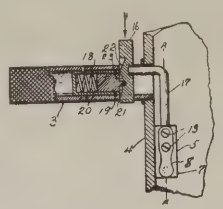
Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. Filed June 4, 1906. The method of braking an alternating-current motor of the commutator type consists in connecting the armature to the source, and connecting the field in shunt to the armature through a phase-shifting device adapted to shift the phase of the voltage impressed on the field substantially ninety degrees from the voltage of the source, and controlling the phase of the voltage impressed on the field to vary the braking effect.

### 967,296. ELECTRIC BRAKING.

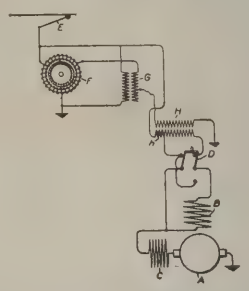
Ernst F. W. Alexanderson, Schenectady, N. Y., assignor to General Electric Company. Filed February 19, 1908. The method of braking electrically in systems employing a plurality of motors of the commutator type adapted to drive a common load, consists in operating a portion of the motors as generators driven by the load and excited from the source of current supply, and operating other of the motors as generators driven by the load to return power to the source, the latter portion of the motors being excited differentially by the current generated in the first-mentioned motors and by the current returned to the source.

### 967,190. SWITCH FOR ELECTRIC TOOLS.

Louis A. Hauck, Cincinnati, Ohio. Filed Jan. 27, 1909. An electric switch for portable electric tools comprises terminals and a movable contact piece for making and breaking the circuit between the terminals (the terminals and contact piece being mounted in a protected position on the body of the tool), a thumb-piece capable of reciprocation, and spring-pressed means adapted to carry the thumb-piece from an intermediate position to one or the other of its extreme positions (the thumb-piece and spring-pressed means being mounted upon the handle of the portable tool), and means for connecting the thumb-piece and the contact piece.



967,190.—SWITCH FOR ELECTRIC TOOLS.



967,295.—BRAKING ALTERNATING CURRENT MOTORS.

### 967,782. MOTOR-CONTROLLING APPARATUS.

Samuel H. Keefer, Plainfield, N. J., assignor to Niles-Bement-Pond Company, Jersey City, N. J. Filed April 14, 1910. The system includes a motor; a reversing switch therefor, including two solenoids; means for controlling the energization of the solenoids; and a winding having a core placed to magnetically act on the movable members of the solenoids to prevent movement thereof when the motor is running, until the counter electromotive force of the motor has fallen to a predetermined amount.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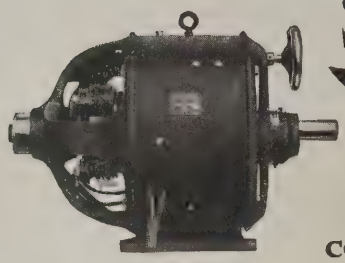

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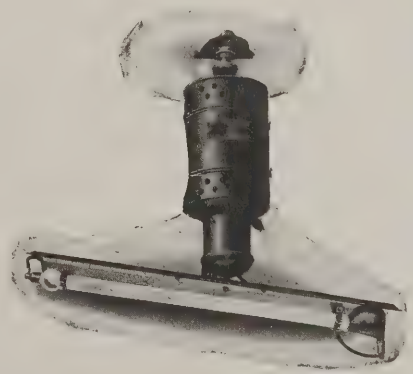

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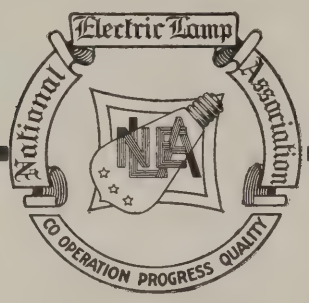


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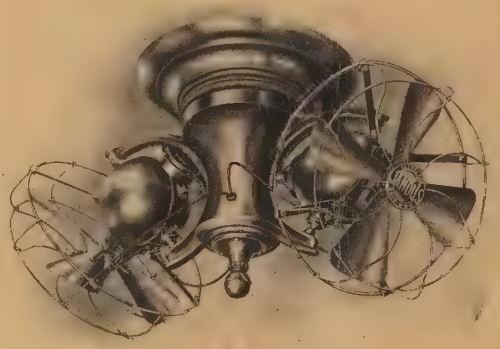

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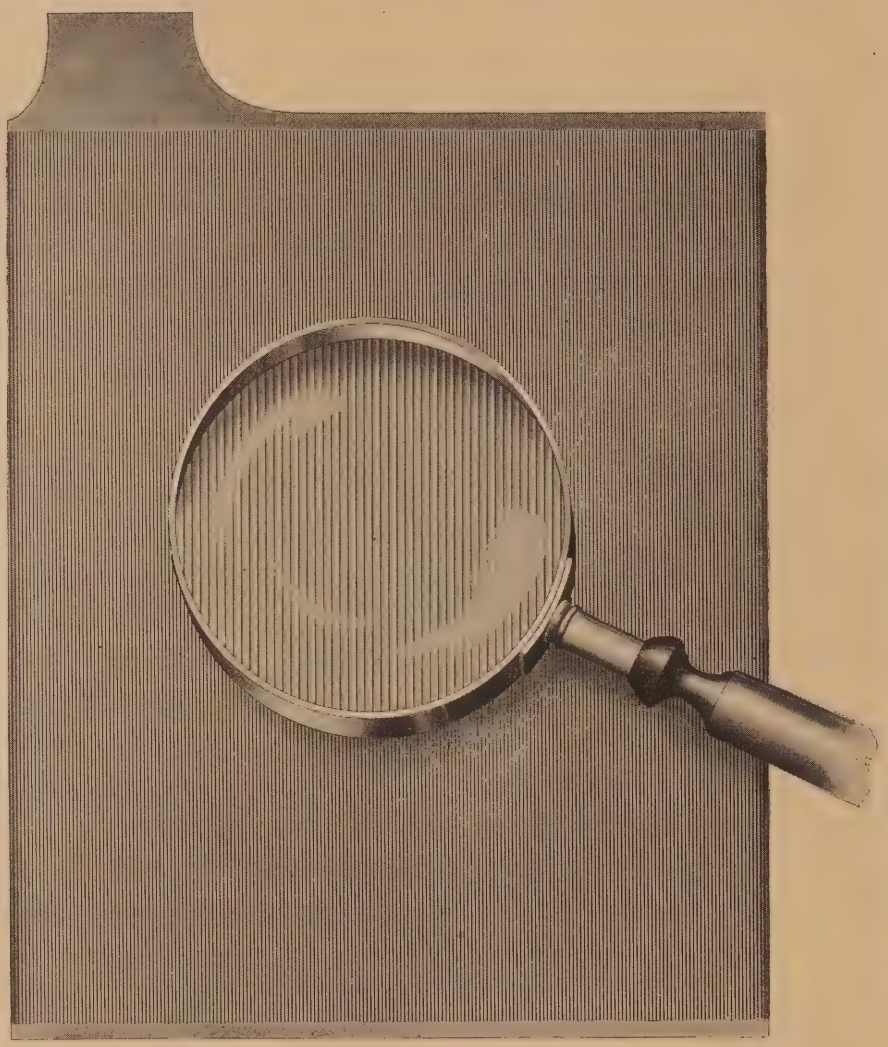

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# CONTENTS
OF THE
# Railway Electrical Engineer

**Vol. II** **June, 1910—May, 1911**


A

Accounts and Reports—Committee Report..... 97
Adjustable Headlight Reflector..... 242
Advance of Electricity on the Railroads..... 174
Ampere-Hour Meters on N. Y. C. & H. R. R. R..... 37
Annual Convention of A. R. E. E..... 86
Association Officers for 1911..... 133
Automatic Regulating Apparatus..... 166
Automatic Train Line Connector..... 16

B

Boiler Scale Prevention by Electricity..... 238

C

Capstans in Germany..... 4
Car Lighting and Electric Traction..... 239
Car Lighting Accounting..... 176
Car Lighting Club.....
.....1, 24, 46, 152, 172, 190, 206, 224, 240
Car Lighting Cost Accounting..... 240
Car Ventilation..... 105
Car Ventilation with the Jandus Gyrofan..... 51
Care of Train Lighting Batteries..... 178
Changing 110 to 60 Volts..... 42
Charging Plug of New Design..... 19
Chicago's Attitude Toward Electrification..... 189
Chicago Great Western's New Steel Train..... 242
Chicago Terminal Electrification Study..... 247
Continuous Current Motor Speeds..... 183

D

Dangers of Gas Lighting on Trains..... 119
Deterioration of Steel Conduit..... 63
Detroit Tunnel Electrical Equipment..... 245
Direct Acting Time Limit Circuit Breakers..... 185
Dope Sheet.....221, 238, 257
Ductile Tungsten..... 3

E

Economics of Railway Electrification..... 113
Edison Storage Battery of 1910.....60, 186, 201, 219
Electric Cranes for Freight Handling..... 72
Electric Lighting of Railway Cars..... 207
Electric Lighting of Roundhouses..... 155
Electrical Operation of Drawbridges..... 120
Electrical Power in Machine Shops..... 69
Electrical Installation at B. & O. Shops..... 125
Electrical Train Equipment in South Africa..... 220
Electrical Work of Physicalische-Technische..... 118
Electrification from the Operating Man's Viewpoint.. 246
Electrification of Steam Railways..... 52
En Route Car Cleaning..... 45
European Car Lighting Systems..... 14
Examination for Baggagemen-Electricians..... 40
Excavation by Electricity..... 84
Exhibitors at A. R. E. E. 1910 Convention..... 141

F

Flangeless Axle Pulley..... 23
Freight Handling By Electricity..... 68
Freight Shed Traversing Crane..... 81

G

German Results with Storage Battery Cars..... 214

H

Harriman Lines Electricians Conference..... 242
High Speed Tools..... 82
Hot Wire System for Tungsten Lamps..... 127

I

Illuminating Engineer, The..... 68
Illumination..... 153
Illumination Terms..... 147
Illuminometer in Railway Practice, The..... 158
Improvement in Lighting Old Cars.....29, 56
Improving Efficiency and Power Factor..... 108
Incandescent Headlight Lamps..... 156
Individual Lighting of Machine Tools..... 111
Is Electric Traction Dangerous?..... 131

L

Latest Data on Single Phase Operation..... 244
Line Shaft Drive vs. Individual Motors..... 73
Locomotive Smoke in Chicago..... 208
London Subway Car Lighting..... 84
Long Step, The..... 45
Loud Speaking Telephones..... 128

M

Maintenance of Way Association Reports..... 247
M. C. B. Train Lighting Report..... 32
Metallic Filament Lamp Manufacture..... 8
Modern Lighting..... 163
Modern Lighting Equipments..... 18
Modern Tendencies in Electric Locomotive Design.. 211
Morris Moskowitz..... 149
Motor Drives..... 67
Motor Drives in the Burnside Shops..... 76
C. L. de Muralt..... 172

O

Opening of the Detroit River Tunnels..... 180

P

Passing of the Telegraph, The..... 189
Pennsylvania Railroad Battery Charging Station..... 11
Practical Illumination..... 162
Practical Operation of Direct Current Motors..... 236
Practical Stunts by Practical Men..... 64
Prentice System of Wireless Train Control..... 228
Pressed Steel Axle Pulleys..... 12
Pullman Company's Shops—Electrical Equipment... 248
Pye, David W..... 149

R

Railway Appliance Show Exhibits..... 252
Railway Telephony..... 254
Rates and Results..... 151
Readville Shops of N. Y., N. H. & H. R. R.....183, 199, 217
Recent Developments in Electric Lighting..... 3
Recording Watt Meters in Railway Shops..... 85

S

Safety in Train Lighting..... 75
Selectors in Railway Telephone Service..... 225
Semi-Annual Convention at Buffalo..... 25
Simple Head-End Voltage Regulator..... 38
Single Phase Locomotive for the Loetschberg Railway 233
Shop and Power House Illumination..... 77
Shop Practice—Committee Report..... 98
Short Flame Arcs..... 15
Smoke..... 205
Some Features of Synchronous Motor Operation..... 198
Specifications—Committee Report..... 94
Standards—Committee Report..... 88
Standard of Illumination, A..... 223
Standardization of Motor Drives..... 70
Steam-Electric Locomotive..... 20
Storage Battery Cell Rejuvenation..... 6
Storage Battery Locomotive..... 152
Storage Battery Trucks for Freight Handling..... 191
Swiss Accumulator Locomotive..... 160

T

Telegraph Superintendents' Association..... 224
Telegraph & Telephone Train Dispatching..... 256
Telephone Equipment of an Electric Railway..... 231
Telephone Selector Resistances..... 231
Terminal Electrifications..... 192
Test of an Electric Headlighting Set..... 78
Test of Storage Battery Car..... 182
Three Methods of Shop Lighting..... 80
Tungsten Talk..... 132
Turning of the Tide, The..... 195
Train Lighting Practice—Committee Report..... 90
Trunk Line Electrification in Austria-Hungry..... 146

V

Variable Speed Induction Motors..... 216
Ventilation of Railway Passenger Cars..... 47
Vital Question, A..... 45

W

Westinghouse, Geo..... 110
Wireless Experiments on the Union Pacific..... 229
Wireless in Railway Service..... 230
Work of the 1910 A. R. E. E. Convention..... 134

# Electric Trunk Line Age

A Record of what Electricity as Motive Power can do under Steam Railroad Conditions

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On December 7th a merger was made of ELECTRIC TRUNK LINE AGE with RAILWAY ELECTRICAL ENGINEER.

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It is already, and will continue to be, the Official Journal of the Association of Railway Electrical Engineers.

By special arrangement, all articles which would have appeared in ELECTRIC TRUNK LINE AGE will hereafter appear in the Electric Traction Section of RAILWAY ELECTRICAL ENGINEER, of which Mr. C. L. de Muralt will be Editor.

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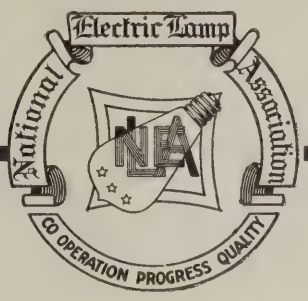


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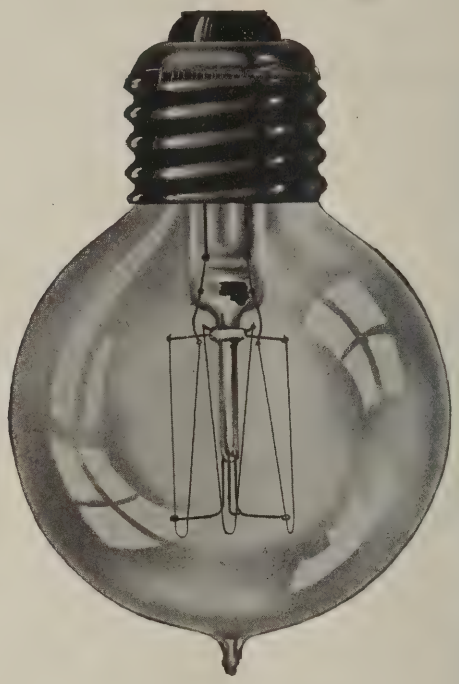

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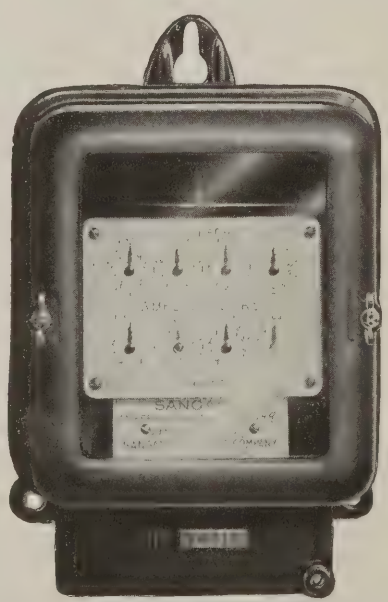

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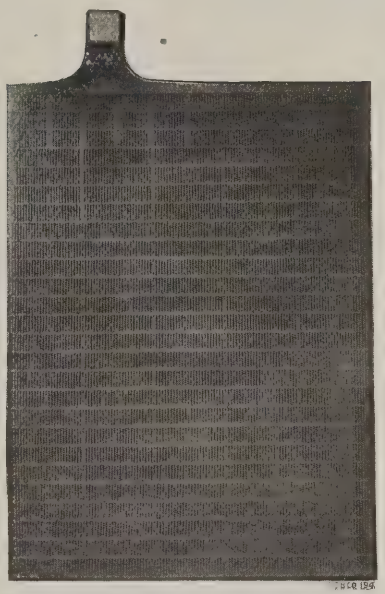

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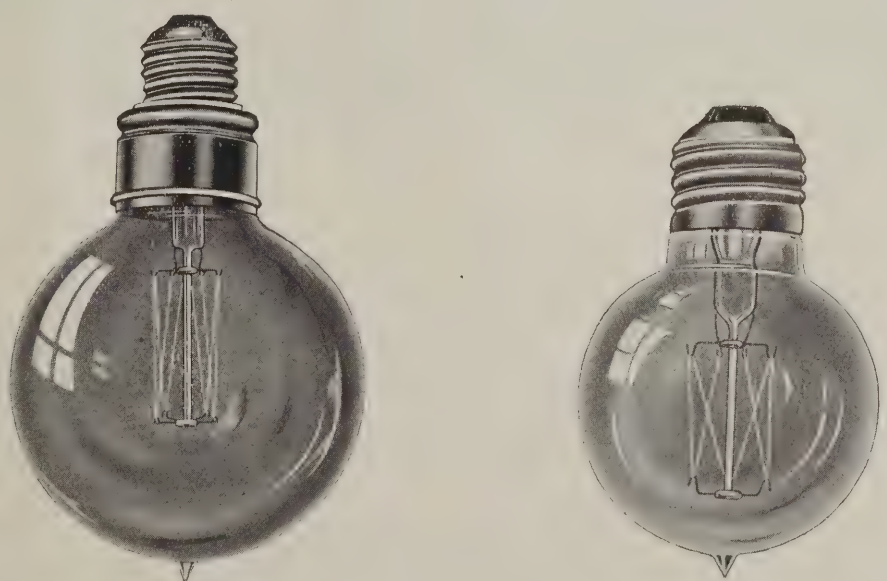

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# Two New Departments

Two new departments are started in this issue of the RAILWAY ELECTRICAL ENGINEER. They will hereafter be regular features each month.

### Electric Traction

Articles such as "The Passing of the Steam Locomotive" and "The Smokeless Railway Train" are common nowadays. And no wonder.

Electric Traction is the biggest thing in the future of the railways. It is in the very near future. Every day sees more of it in the present.

The Electric Traction Section, edited by Mr. C. L. de Muralt, Professor of Electrical Engineering at the University of Michigan, will keep our readers abreast of the trunk line traction developments of the day.

### Machine Shop

Electric motor drive is fast becoming standard practice in railway shops. It is only a question of a few years till the line shaft will be as obsolete as the pin coupler.

The change from the old style to the new presents many interesting problems for the shop man. More and more of his time and attention will have to be devoted to them.

The Shop Section, edited by Mr. Geo. W. Cravens, will be for the purpose of giving a clear understanding of how these problems are to be solved.

**Both these fields are of the greatest interest and importance to railway men, and especially to those in the Motive Power and Engineering Departments.**

# A Special Subscription Offer

To make sure that every railway man interested in electricity will take advantage of this opportunity to provide himself with the best and most valuable up-to-date information on his work we are offering to send new subscribers the RAILWAY ELECTRICAL ENGINEER from January 1911 to March 1912, inclusive on receipt of one dollar accompanying the attached blank.

Remember that this is the only paper devoted to electricity on the steam railway—to electric traction under trunk line conditions.

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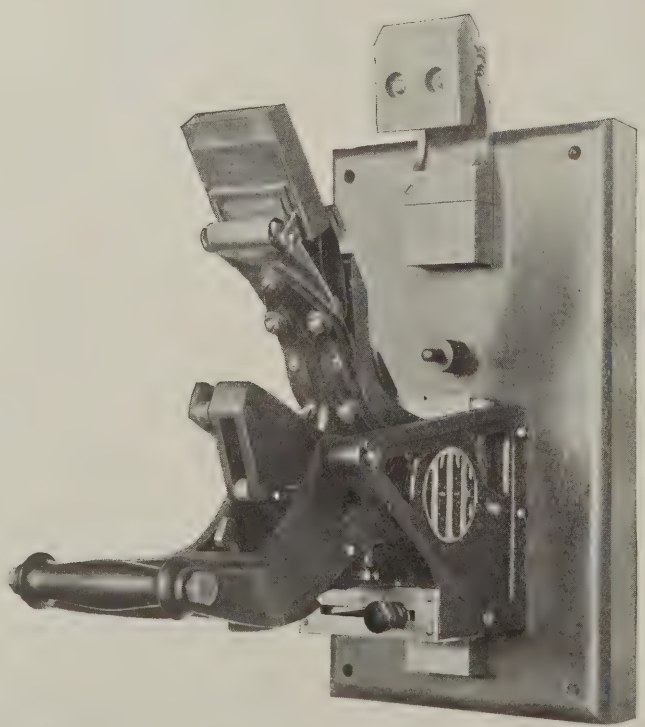

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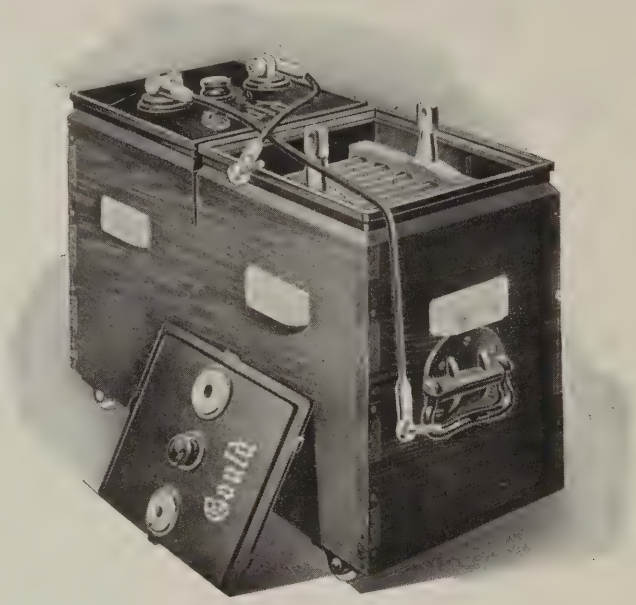


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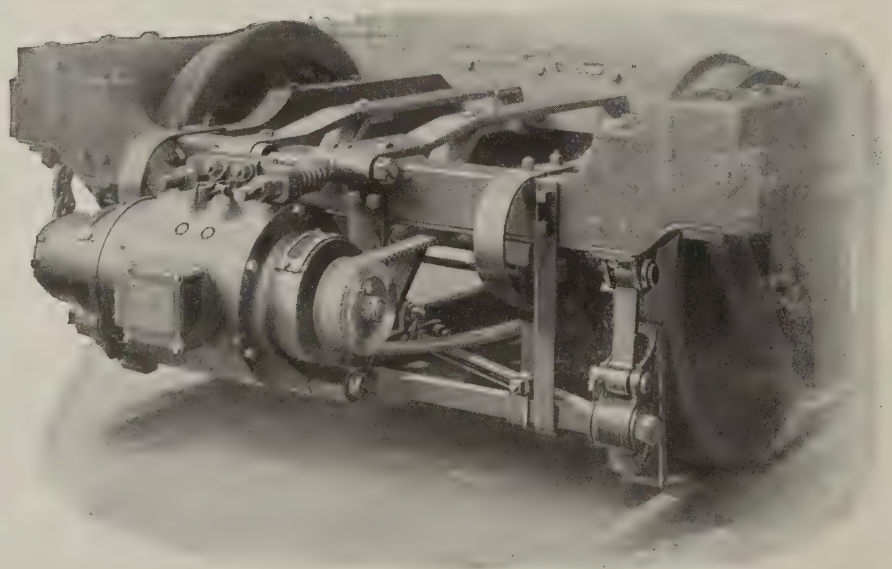

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# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

WRAY PUBLISHING CO.

EDWARD WRAY, President. J. G. WRAY, Sec. & Treas.

RALPH BIRCHARD, Manager.

92 LA SALLE ST.

CHICAGO

Telephone Main 2457.

Editors ..... Edward Wray, C. L. de Muralt, Geo. W. Cravens, Ralph Birchard

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.


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TERMS OF SUBSCRIPTION

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| United States, Canada and Mexico | Per Year, $1.00 |
| Other Foreign Countries within the Postal Union | " " 1.50 |
| Single Copies, Domestic | 10 cents |
| Single Copies, Foreign | 15 cents |


OUR OBJECT.

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


Editorials—
- The Year Ending December 31st, 1910 ..... 171
- Announcement Extraordinary ..... 171

C. L. de Muralt ..... 172
Association News ..... 172
Car Lighting Club ..... 172
Chicago Section of I. E. S. ..... 173
The Advance of Electricity ..... 174
Car Lighting Accounting ..... 176
The Care of Train-Lighting Batteries ..... 178
Electric Traction Section—
- Foreword ..... 179
- Opening of Detroit River Tunnel ..... 180
- Electrification in Montreal ..... 182
- Test of Storage Battery Car ..... 182
- Steam Road in New York to Electrify ..... 182
- Chicago Terminal Electrification ..... 182

Shop Section—
- Continuous Current Motor Speeds ..... 183
- Notable Railroad Shop Electrification ..... 183

Direct Acting Time Limit Circuit Breakers ..... 185
The 1910 Edison Storage Battery ..... 186
General News and Personal Mention ..... 18
Recent Patents ..... 14
Association Directory ..... 14


### The Year Ending December 31, 1910.

THE year 1910 has witnessed a remarkable growth and expansion of the use of electricity on the steam railways. The number of electric lighted cars has increased at least one-half. Notable shop motor installations are those on the New York, New Haven and Hartford, Chicago and Northwestern, and Chesapeake and Ohio. It is safe to say that four-fifths of the new shop machinery installed during the year is motor driven. The most important developments in electric traction under steam railway traffic conditions have been the opening of the Pennsylvania Terminal in New York and the Michigan Central Tunnels under Detroit River at Detroit. Announcement has been made of the intended extension of the electrified zone on the New York Central and on the New York, New Haven and Hartford, while it seems practically certain that electric traction will be supplied for a considerable distance on each side of the Cascade Tunnel on the Great Northern.

This development has been hindered somewhat by the depression which has prevailed in railway circles. A good deal of new building and equipment has been held up. A great deal of work has been planned which will be executed in the near future. From present indications the year ending December 31, 1911, should "bust all records wide open."

### Announcement Extraordinary.

ON December 7, arrangements were completed whereby the ELECTRICAL TRUNK LINE AGE is consolidated with the RAILWAY ELECTRICAL ENGINEER. This means that the trunk line traction field, which we feel has not hitherto been adequately covered in this paper, will hereafter get the attention which is its due.

The ELECTRIC TRUNK LINE AGE was started in October, 1907. It was a monthly publication devoted to electric trunk line traction matters and edited by C. L. de Muralt. Under the new arrangement Mr. Muralt will write for the Traction Section of the RAILWAY ELECTRICAL ENGINEER the articles which would otherwise have appeared in the ELECTRIC TRUNK LINE AGE. The short sketch of his life which appears in the following page will tell our readers something more of Mr. Muralt. Suffice it to say here that he is one of the foremost electric traction authorities in the country or in the world.

At the same time it was arranged to secure the services of Mr. George W. Cravens as editor of a Shop Section. This section will be devoted to practical problems arising out of the use of electricity in railway shops. It will not be technical, neither will it be so obvious as to be trite. It will supply those working with electrical machinery with up-to-date, accurate and practically useful information. Our aim is to make this section of the greatest possible service to the man on the job.

Mr. Cravens was for a long time associated with the General Electric Company and later engaged in independent consulting engineering work in Chicago. He has been an active contributor to the technical press, and his wide experience in all branches of electrical work makes him peculiarly fitted to edit a section of this kind.

We are pleased, indeed, to be able to make this announcement at this time. We feel that these two additions to the staff strengthen the paper greatly. We like to think of it as a sort of Christmas gift to our old subscribers and to the new ones which have come to us with the ELECTRIC TRUNK LINE AGE. We are giving them two papers for the price of one—the price of the combined papers will be the same as that of each of them before.

Incidentally, we are mighty glad to be able to hand our advertisers this little Christmas present of increased circulation and increased advertising efficiency.

### C. L. DE MURALT.

Carl Leonard de Muralt was born in Brooklyn, N. Y., Jan. 29, 1873. When he was six years of age his parents removed to Switzerland, where he was educated, graduating from the Polytechnic at Zurich, Switzerland. The call of the land of his nativity was strong within him, however, and soon after his graduation he returned to America and entered the employ of the General Electric Co., at Schenectady, N. Y. He spent some three years in the shops, and was then made engineer of the Company's European Lighting and Power Department. The design and erection of some of the most important plants installed throughout Europe came under his direct charge while acting in this capacity, the most noteworthy, perhaps, being the city lighting plant at Madrid, Spain, which was one of the earliest electric plants to employ high tension alternating current.

His work soon brought Mr. de Muralt in close contact with the electric traction field, and he became associated with the firm of Brown, Boveri & Company of Baden, Switzerland, widely known for their pioneer work in the application of electricity to railroads. Switzerland, with her abundance of Alpine waterpower, has from the earliest days of electricity held out an inviting field for the electrical engineer, and the mountainous profile has produced some extremely hard problems. Existing systems of electric operation were found entirely inadequate and it was here that the three-phase system was first evolved to meet and conquer the unusual difficulties.

C. L. de Muralt.

Mr. de Muralt had an exceptional opportunity to observe the successful results which attended the working of electric traction in practice. As the many theoretical objections were dissipated by practical demonstrations, he became more and more firmly convinced of its particular field of usefulness in very heavy railroad service.

Mr. de Muralt returned to this country in 1903 and engaged in electric traction practice as a consulting engineer. This practice has been maintained ever since. His connection with the University of Michigan began in 1906. He is now professor of electrical engineering in that institution.

In 1907 he began the publication of ELECTRIC TRUNK LINE AGE—A Record of What Electricity as Motive Power can do under Steam Railroad Conditions. This magazine, issued monthly up to December, 1910, has now been merged with the RAILWAY ELECTRICAL ENGINEER, Mr. de Muralt assuming the position of Editor of the Traction Department of the combined papers.

### CAR LIGHTING CLUB WEDNESDAY, JAN. 4, 1911.

### ASSOCIATION NEWS.

**This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.**

**It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.**

### EXECUTIVE COMMITTEE MEETING.

The Executive Committee met December 8 in Chicago at the Great Northern Hotel. Twenty applications for membership were approved. The Editing Committee reported that the editing of the Proceedings for 1910 is practically complete. It was decided to sell a limited amount of advertising space in the Proceedings at the rate of $25 per page.

### CAR LIGHTING CLUB.

The December meeting of the Car Lighting Club, held at Chicago Press Club on the evening of Dec. 7, was one of the most successful in the history of the organization. Fifty-five members were present to hear the paper by Mr. S. W. Everett on "Care of Train Lighting Batteries" and the interesting discussion which followed. This paper is printed in another place in this issue of the RAILWAY ELECTRICAL ENGINEER.

The principal discussion was by C. J. Causland of the Pennsylvania and H. M. Beck of the Electric Storage Battery Company. Mr. Causland took a stand in favor of lead containing jars as against rubber trays, and expressed himself as favoring the stop charge and taper charge devices. Mr. Beck emphasized the need for complete charging, saying that the danger of injury from single long overcharges was very slight. D. J. Cartwright reported that the cost of all repairs to the batteries in car lighting service on the Lehigh Valley R. R. averaged about $40 per car per year. He urged all those in charge of battery handling to keep accurate records of maintenance costs in order that comparisons might be made for the benefit of all concerned. In regard to the changing of the regulator setting with the seasons of the year he said it was customary to allow for about twice as much charging in December as in June, the setting being changed gradually.

Mr. C. L. de Muralt, Professor of Electrical Engineering at the University of Michigan, and Editor of the Electric Traction Department of the RAILWAY ELECTRICAL ENGINEER, addressed the meeting on the subject of "Electric Traction Systems." He said there were four systems of electric traction in use today: (1) Storage Battery Locomotives, (2) Direct Current, transmitted either by trolley or third rail, (3) Single-Phase Alternating Current, (4) Three-Phase Alternating Current. Each of these systems is particularly adapted to certain conditions. Where the transmission lines are objectionable, as for instance in crowded city streets, the storage battery has decided advantages. The greatest advantage of Direct Current system is that the apparatus used in it has become thoroughly standardized, and so, cheaper in first cost. The disadvantage is that where the current must be transmitted over considerable distances the cost of the transmission line is much higher owing to the fact that direct current motors cannot be built to operate at very high voltages. The Single-Phase

system overcomes this objection but requires motors of much greater size and cost for a given capacity than those operating with three-phase current. The Three-Phase system appears to be best adapted for trunk line service such as that maintained on the ordinary steam railroad. The disadvantage of this system is that two trolley wires are required for its distribution. This is not serious on long lines but causes great complications in yards where there are numerous cross-overs and switches.

Mr. Muralt urged the members to consider all the various systems and recommend when the time came the one best adapted to the particular service required. He said there was no real reason why direct current should not be used within the suburban range of a terminal, and single-phase or three-phase current on the main line outside.

The next meeting of the Club will be held January 4, 1911, at the same place. A paper on "The Selection and Care of Motors for Railway Shops" will be presented by W. S. Taussig of the General Electric Co.

## GAS EXPLOSION WRECKS SUBSTATION

An explosion of illuminating gas on the morning of December 19th wrecked the wing of the substation containing the storage batteries and transformers of the New York Central & Hudson River Railroad at Fiftieth Street and Lexington Avenue, New York City. A car, overrunning the buffer on a side track, smashed the concrete column containing the gas pipes supplying the yards. Leaking gas filled the shed underneath the substation. By some means the mixture of gas and air was ignited, and a terrific explosion resulted. Ten persons were killed and many more seriously injured. Among the prominent railroad men killed were V. B. Livermore, Patrick Jordan, and Charles McMorrow.

V. B. Livermore was an operating inspector for the electrified zone of the New York Central. He was 46 years of age and had been continuously in the employ of the New York Central Railroad since 1889. His work took him to all points of trouble with the electrical equipment.

Patrick Jordan was general foreman of maintenance of way. Charles McMorrow was a third rail man.

The explosion completely destroyed a large amount of valuable electrical equipment and tied up all trains on the division for several hours.

## SELF-DISCHARGE OF STORAGE BATTERIES.

"The Self Discharge of Plante and Faure Storage Batteries" was the subject of a paper by O. W. Brown and W. G. Bowers presented at the Annual Convention of the American Electrochemical Society.

A comparison of the two types of batteries was made. Four makes of batteries were tested: (1) Both plates of the Faure type; (2) both plates of the Planté type; (3) both plates of the Planté type more deeply formed; (4) a Planté positive and a box grid negative. These all had about 100 ampere-hours capacity, and were treated alike. The first was the only one to have the same capacity after fifty cycles as at the start, and it even gained slightly. The loss in numbers 2 and 3 was 13.5 and 7.5 per cent, respectively. The loss in 4 was 2.5 per cent. It was shown that the Planté type continually decreases in capacity. The tests on standing showed that type 1 did not suffer from twenty days on open circuit, but all others showed deterioration. The conclusions are that the Planté type loses capacity on open circuit, whereas the Faure type loses very slightly or not at all, and the self-discharge is less. The capacity of the Faure type is restored by use, while that of the Planté type is not.

## CHICAGO SECTION OF I. E. S.

The December meeting of the Chicago Section of the Illuminating Engineering Society was held following a luncheon at the Great Northern Hotel at noon, December 15. The subject for discussion was a paper by J. M. Bryant and H. G. Dake, of the University of Illinois, on "Comparative Costs of Producing Light with Different Illuminants," which was read by Mr. Hake.

This paper makes a comparison of operating costs of 41 different illuminants—31 electric and the remainder gas, gasoline, kerosene, acetylene, etc. The basis of comparison was the actual cost of producing 100,000 lumen-hours. No account was taken of the effect of shades or other distributing apparatus.

The electric lamps were arranged in the following order of cost, with current at 10 cents per kilowatt-hour, the cheapest lamp being placed first.

1. Regenerative d.c. 5.5 amp. series and mult. arc.
2. Magnetite d.c. 6.6 amp. series arc.
3. Flame d.c. 8-10 amp. inclined carbon arc.
4. Mercury-vapor 3.5 amp. lamp.
5. Flame d.c. 8 amp. vertical carbon arc.
6. Luminous d.c. 6.6 amp. multiple arc.
7. Open d.c. 9.6 amp. series arc.
8. Magnetite 4 amp. series arc.
9. Flame a.c. 10 ampere arc.
10. Open d.c. 6.6 amp. series arc.
11. Tungsten 6.6 amp. series incandescent.
12. Flame inclined-carbon a.c. 10 amp. arc.
13. Inclosed d.c. 6.6 amp. series arc.
14. Luminous 4 amp. multiple arc.
15. Tungsten multiple incandescent.
16. Nernst a.c. 3-glower.
17. Nernst d.c. 3-glower.
18. Inclosed a.c. 6.6-7.5 amp. series arc.
19. Tantalum d.c. and a.c. multiple incandescent.
20. Carbon 3.1 watt multiple incandescent.
21. Carbon 3.5 watt 6.6 amp. incandescent.
22. Carbon 3.5 watt multiple incandescent.
23. Inclosed d.c. 3.5-5 amp. multiple arc.
24. Inclosed a.c. 4-6 amp. multiple arc.

Comparisons were also made for the different types of gas, gasoline, and kerosene lamps. These showed that the inverted mantle gas lamp has the lowest operating cost of any illuminant other than electric lamps, and that is compares very favorably with the best of these.

Ward Harrison, of the National Electric Lamp Association, stated that tests made by its engineering department showed the average candle-power of arc lamps between trims to be about 80 per cent of the initial candle-power; that of flame arcs to be about 70 per cent; Copper Hewitt lamps, 80 per cent; while for incandescent lamps, about 91 per cent of the initial has been found a fair average value.

## AN OMISSION.

In the article on the "Electric Headlight Lamp for Locomotives," by Mr. Roscoe Scott, published last month in these columns, the data for the curves of color values for various light sources was taken from an article by Mr. R. B. Hussey entitled "A New Method of Color Testing," in GENERAL ELECTRIC REVIEW of September, 1910. This reference was unfortunately omitted in printing the article. We take pleasure in correcting this mistake now.

We are pleased also to make a correction of an error in connection with the publication of the article by C. Toone in the December issue. Acknowledgement for this article should have been made to the London Electrical Review.

# The Advance of Electricity

## IN RAILROAD SERVICE

The use of electricity on the steam railroads seems at first glance, of rather minor importance. The entire investment in railroads is so stupendous that a statement of the capital invested in electrical equipment suffers inevitably by comparison with the whole. Neverthless, when the item is considered separately, it is seen to be of very considerable size.

It was the intention of this magazine to secure statistics covering all the uses of electricity on all railroads owning or operating over 200 miles of track. To carry out this plan cards asking several questions were sent to the men in authority on each of the railroads. The questions were: First, the number of cars equipped with each of the three systems of electric car lighting; second, the number of stations, offices, etc., electric lighted, with an estimate of the total wattage they consumed; third, the amount of electrical power used in railway shops.

The returns from these cards are shown in the accompanying table. They are necessarily incomplete. Neverthless it is believed that they show the car lighting situation with considerable accuracy, and give an idea of the vast amount of electric light and power being used in stations and shops. A great many roads did not reply at all although several letters were sent to them. Some of these probably had nothing to report, others

ELECTRICITY ON THE STEAM RAILWAYS.

| | ——Electric Lighted Cars.—— | | | Shops. | Stations Etc. | | |
|---|---|---|---|---|---|---|---|
| Railroad. | H-E. | Axle. | St. Stor. | Total. | K. W. | No. | K. W. |
| A. T. & S. F. | ... | 604 | | 604 | .... | ... | .... |
| B. & O. | 70 | 48 | 2 | 120 | .... | ... | .... |
| B. R. & P. | ... | 5 | .. | 5 | 775 | 24 | 150 |
| Can. Pac. | ... | 34 | .. | 34 | 8900 | 150 | 890 |
| C. & A. | ... | 44 | 61 | 105 | 1600 | 25 | .... |
| C. & E. I. | ... | 59 | 6 | 65 | .... | ... | .... |
| C. M. & St. P. | 872 | 11 | .. | 883 | 4000 | 187 | 2000 |
| C. & G. W. | ... | 63 | .. | 63 | 1500 | ... | .... |
| C. & W. I. | ... | ... | .. | ... | 500 | 23 | 1975 |
| C. & N. W. | 200 | 40 | 5 | 245 | 5500 | ... | .... |
| C. R. I. & P. | 240 | ... | .. | 240 | .... | ... | .... |
| Col. Midland | ... | ... | .. | ... | 200 | 6 | 720 |
| C. C. C. & St. L. | ... | 109 | 61 | 170 | .... | ... | .... |
| D. L. & W. | ... | 14 | 4 | 18 | 5400 | 235 | 1420 |
| G. T. | ... | 26 | .. | 26 | .... | ... | .... |
| Ill. Cent. | ... | 27 | 13 | 40 | .... | ... | .... |
| L. V. | ... | 73 | .. | 73 | .... | ... | .... |
| Long Island | ... | 9 | 2 | 11 | 200 | 165 | 418 |
| L. & N. | ... | 80 | .. | 80 | 4185 | 243 | 700 |
| Mobile & Ohio | ... | 6 | .. | 6 | .... | ... | 500 |
| Mich. Central | ... | 45 | 66 | 111 | 25 | ... | .... |
| M. St. P. & S. S. M. | ... | 30 | 3 | 33 | .... | ... | .... |
| N. Y. O. & W. | ... | 1 | .. | 1 | .... | 215 | .... |
| National Rys. of Mex. | ... | 18 | .. | 18 | 1500 | ... | .... |
| National Transcontinental | ... | ... | .. | ... | 3075 | 3 | 150 |
| Norfolk & Western | ... | 13 | .. | 13 | 2400 | 23 | 165 |
| N. Y. N. H. & H. | ... | 350 | .. | 350 | .... | ... | .... |
| N. Y. C. | ... | 232 | 122 | 354 | .... | ... | .... |
| N. Y. C. & St. L. | ... | 4 | ... | 4 | .... | ... | .... |
| N. P. | ... | 7 | ... | 7 | .... | ... | .... |
| Pennsylvania | ... | 153 | 947 | 1100 | .... | ... | .... |
| Pere Marquette | ... | 86 | ... | 86 | .... | ... | .... |
| Pullman Company | ... | 1600 | ... | 1600 | .... | ... | .... |
| S. P. of Mexico | ... | ... | 1 | 1 | 32800 | ... | 700 |
| Southern | ... | 154 | .. | 154 | .... | ... | .... |
| S. P. Q. S. | 30 | ... | .. | 30 | 750 | 12 | 25 |
| St. L. & S. W. | ... | 4 | .. | 4 | 1200 | 7 | 15 |
| St. L. & S. F. | ... | 154 | 2 | 156 | 2750 | ... | .... |
| S. P. | 140 | 140 | 12 | 292 | .... | ... | .... |
| T. & B. V. | ... | 17 | ... | 17 | 800 | 3 | 40 |
| U. P. | 140 | 17 | ... | 157 | .... | ... | .... |
| Vandalia | ... | 11 | 32 | 43 | 250 | 5 | 50 |
| Wheeling & Lake Erie | ... | 1 | 3 | 4 | 500 | ... | .... |
| W. P. | ... | 88 | ... | 88 | 370 | ... | .... |
| Total | 1692 | 4377 | 1342 | 7411 | 79180 | 1306 | 9918 |

did not feel like giving out the information, while others —and this group is probably by far the largest—intended to reply but failed to do so on account of the pressure of other work.

In many instances these reports fail to include cars equipped for electric lighting, but also provided with auxiliary gas equipment so that they may be used in trains not having generator-baggage cars. As nearly as can be determined the total number of cars equipped for electric lighting in the United States today is about 14,000.

The reports of station lighting are very incomplete. On account of the fact that so many stations are lighted with current bought from local central stations with which neither the mechanical nor electrical departments of the railways have anything to do, figures on this are exceedingly hard to get.

The power used in shops is difficult to get at on account of the fact that various departments have jurisdiction over this work on various railroads. Nevertheless the figures given, show to what a great extent electricity is superseding shafting in railroad shops.

The extent to which electrification is being carried on trunk lines is well shown by the accompanying tables taken from the appendices to the paper on "Electrification of Railroads," by Geo. Westinghouse. The locomotives shown are all built for heavy trunk line service. The horsepower ratings cannot be taken for comparison in every case for the reason that some of them apply only for a short period, usually one hour. However, for purposes of general comparison, they are sufficiently accurate.

The alternating current locomotives are much more powerful in most cases, than those of the continuous current type. The maximum tractive effort of the Great Northern 3-phase locomotives is 77,000 pounds while that of the New Haven locomotives when operating on alternating current is over 88,000 pounds. The latter are built to pull passenger trains at comparatively high speeds.

The reason for most electrification which has taken place in this country has been either smoke difficulties (as in tunnels and cities) or legal enactments. Most railroad managers are not yet convinced that actual savings in operating costs can be effected by electrification. The announcement recently made that the electric zone

TABLE 2 DATA ON ELECTRIC LOCOMOTIVES OF AMERICAN DESIGN
BUILT BY THE WESTINGHOUSE ELECTRIC & MFG. CO.

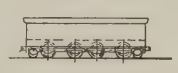
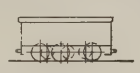
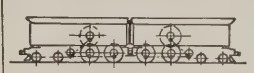
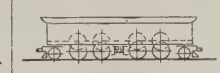
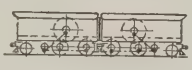
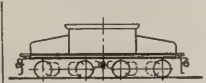
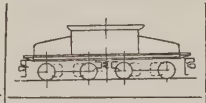
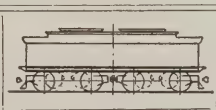
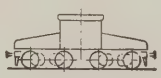
| |  |  |  |  |  |
|---|---|---|---|---|---|
| Built for | New Haven | Grand Trunk St. Clair Tunnel | Pennsylvania | New Haven | New Haven |
| Electric system | A.C., D.C. | A.C. | D.C. | A.C., D.C. | A.C., D.C. |
| Service | Passenger | Frt. & Pass. | Passenger | Frt. & Pass. | Frt. & Pass. |
| First placed in service | July 1907 | February 1908 | 17,000-mile test | 3000-mile test | building |
| No. in service or on order May 1910 | 41 | 6 | 24 | 1 | 1 |
| No. motors per locomotive | 4 | 3 | 2 | 4 | 2 |
| Armature diameter, inches | 39½ | 30 | 56 | 39½ | 76 |
| Core length, including vent opening, inches | 18 | 14¾ | 23 | 13 | 13 |
| Weight one motor, pounds | 16,420 | 15,660 | 45,000 | 19,770 | 41,600 |
| Weight all motors on locomotive | 65,680 | 46,980 | 90,000 | 79,080 | 83,200 |
| Weight all electrical parts | 110,400 | 58,400 | 127,200 | 130,000 | 135,000 |
| Weight all mechanical parts | 94,100 | 73,600 | 204,800 | 130,000 | 125,000 |
| Weight complete locomotive | 204,500 | 132,000 | 332,000 | 260,000 | 260,000 |
| Weight on driving wheels | 162,000 | 132,000 | 207,800 | 180,000 | 180,000 |
| Weight complete locomotive for A.C. operation | 196,000 | 132,000 | D.C. | 241,000 | 240,000 |
| Max. guar't'd speed, miles per hr. | about 86 | 30 | about 80 | 45 | 45 |
| Feature limiting speed | track | armatures | connecting rod | armatures | armatures |
| Max. tractive effort | 19,200 | 43,800 | 69,300 | 40,000 | 40,000 |
| Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation | 88,700 | none | none | 18,500 | 17,500 |
| Designed for trailing load, tons | 250 | 500 | 550 | {1500 freight / 800 pass.} | {1500 freight / 800 pass.} |
| Balance speed on level with above load | about 75 | about 25 | 60 | {35 freight / 45 pass.} | {35 freight / 45 pass.} |

TABLE 3 DATA ON ELECTRIC LOCOMOTIVES OF AMERICAN DESIGN
BUILT BY THE GENERAL ELECTRIC COMPANY

| | |  |  |  |  |
|---|---|---|---|---|---|
| Built for | N. Y. C. & H. R. R. | Detroit River Tunnel | B. & O. R. R. | Great Northern | Paris-Orleans |
| Electric system | D.C. | D.C. | D.C. | 3-phase | D.C. |
| Service | Passenger | Frt. & Pass. | Frt. & Pass. | Frt. & Pass. | Passenger |
| First placed in service | July 1906 | tests completed | March 1910 | July 1909 | 1899 |
| No. in service or on order May 1910 | 47 | 6 | 2 | 4 | 11 |
| No. motors per locomotive | 4 | 4 | 4 | 4 | 4 |
| Armature diameter, inches | 29 | 25 | 25 | 35¾ | 23½ |
| Core length, including vent. opening, inches | 19 | 11½ | 11½ | 16¼ | 12 |
| Weight one motor, pounds | 18,150 | 10,560 | 10,560 | 15,000 | 8,855 |
| Weight all motors on locomotive | 72,600 | 42,240 | 42,240 | 60,000 | 35,420 |
| Weight all electrical parts | 91,200 | 54,000 | 54,000 | 109,000 | 42,500 |
| Weight all mechanical parts | 138,800 | 146,000 | 130,000 | 121,000 | 67,500 |
| Weight complete locomotive | 230,000 | 200,000 | 184,000 | 230,000 | 110,000 |
| Weight on driving wheels | 141,000 | 200,000 | 184,000 | 230,000 | 110,000 |
| Weight complete locomotive for A.C. operation | D.C. | D.C. | D.C. | 230,000 | D.C. |
| Max. guar't'd speed, miles per hr. | 75 | 30 | 55 | 30 | 45 |
| Feature limiting speed | track | armature | armature | armature | armature |
| Max. tractive effort | 47,000 | 67,000 | 61,000 | 77,000 | 37,000 |
| Loco. wt. in excess of 18% adhesion Max. T.E., A.C. operation | none | none | none | none | none |
| Designed for trailing load, tons: Freight | | 900 on 600 / 2% grade | 850 on 500 / 1½% grade | 500 on 2.2% grade | |
| Designed for trailing load, tons: Passenger | | Freight 20.5 / Pass. 22 | Freight 26 / Pass. 30 | | |
| Balance speed on level with above load | {435 / 63} | | | 15 | {300 / 32} |

of the New York, New Haven, and Hartford is soon to be extended to include the division between New Haven and Stamford, Connecticut, would seem to indicate, however, that for this particular line at least, electrical operation is cheaper. On this stretch of track there is no serious smoke problem, nor have the authorities intervened to enforce electrification.

From the tables of lines electrified it is seen that the Spokane and Inland Empire is the longest electric trunk line in operation today, although the West Jersey and Seashore has more miles of track. Six hundred volts has been used on most of the direct current installations, while single phase current is being used at voltage from 3,000 to 12,000.

*Continuous-Current Electrification on Steam Railways and in Trunk Line Service.*

| Road. | Miles: Of line. | Miles: Single track. | Line voltage. | Motor cars: No. | Motor cars: H.p. | Locomotives: No. | Locomotives: H.p. |
|---|---|---|---|---|---|---|---|
| New York Central | 33 | 132 | 650 | 137 | 400 | 47 | 2,200 |
| Pennsylvania | 20 | 75 | 650 | 180 | 400 | 24 | 4,000 |
| West Shore | 44 | 106 | 650 | 20 | 360 | .. | ..... |
| Long Island | 42 | 125 | 650 | 137 | 400 | 2 | 1,200 |
| West Jersey & Seashore | 75 | 150 | 650 | 68 | 400 | .. | ..... |
| Baltimore & Ohio | 37 | 7.4 | 600 | .. | ... | 2.5<br>5 | 1,600<br>1,100 |
| Northeastern Railway | 37 | .. | 600 | .. | 300 | 2 | 600 |
| Mersey Tunnel | 4.8 | .. | 600 | 24 | 400 | .. | ..... |
| Lancashire & Yorkshire | 18 | 60 | 600 | .. | 600 | .. | ..... |
| Great Western | 5 | .. | 600 | .. | 600 | .. | ..... |
| Metropolitan Railway | .. | 67 | 600 | 56 | 600 | 10 | 800 |

*Single-Phase Electrification on Steam Railways and in Trunk Line Service.*

| Road. | Miles: Of line. | Miles: Single track. | Line voltage. | Motor cars: No. | Motor cars: H.p. | Locomotives: No. | Locomotives: H.p. |
|---|---|---|---|---|---|---|---|
| N. Y., N. H. & H.: | | | | | | | |
| Main line | 21 | 100 | 11,000 | 4 | 600 | 41 | 1,400 |
| New Canaan Branch | 8 | 8 | 11,000 | 2 | 500 | 2 | 1,600 |
| Grand Trunk | 3.5 | 12 | 3,300 | . | ... | 6 | 900 |
| Erie: Rochester Division. | 34 | 34 | 11,000 | 6 | 400 | .. | ..... |
| Colorado & Southern: | | | | | | | |
| Denver & Interurban | 46 | 46 | 11,000 | 8 | 500 | .. | ..... |
| Baltimore & Annapolis: | | | | | | | |
| Short line | 25 | 30 | 6,600 | 12 | 400 | .. | ..... |
| Swedish State Rys. | 7 | 7 | 20,000<br>3,300 | 2 | 240 | 1 | 300 |
| Midland Ry. of England | 8.5 | 17 | 6,600 | 1<br>2 | 300<br>360 | .. | ..... |
| Prussian State | 16.5 | 31 | 6,600 | 20<br>42<br>54 | 250<br>400<br>345 | 1 | 1,500 |
| Lon., Brighton & S. Coast. | 8.6 | 17.2 | 6,000 | 16 | 460 | .. | ..... |
| Rotterdam-Haag-Scheveningen | 20.5 | 46.5 | 10,000 | 19 | 360 | .. | ..... |
| Spokane & Inland | 129 | 129 | 6,600 | 28 | 400 | 5 | 720 |
| Midi Ry. of France | 75 | .. | 12,000 | 30 | 500 | 5<br>2 | 500<br>1,600 |

*Three-Phase Electrification on Steam Railways and in Trunk Line Service.*

| Road. | Miles: Of line. | Miles: Single track. | Line voltage. | Motor cars: No. | Motor cars: H.p. | Locomotives: No. | Locomotives: H.p. |
|---|---|---|---|---|---|---|---|
| Gt. Nor. (Cascade tunnel) | 4 | 6 | 6,600 | .. | ... | 4 | 1,900 |
| Italian State Railways: | | | | | | | |
| Valtelina Railway | 66 | .. | 3,000 | 10 | 400 | 2<br>7 | 800<br>1,500 |
| Giovi Railway | 12.4 | 37.3 | 3,000 | .. | ... | 20 | 2,000 |
| Mt. Cenis Tunnel | 4.4 | .. | 3,000 | .. | ... | 10 | 2,000 |
| Savona Ceva | .. | .. | 3,000 | .. | ... | 10 | 2,000 |
| Swiss Federal Railways: | | | | | | | |
| Simplon Tunnel | 13.7 | 24.3 | 3,000 | .. | ... | 2 | 1,100 |
| Garagal Santa Fe (Spain) | 13.1 | 14.4 | 5,500 | .. | ... | 2<br>5 | 1,300<br>320 |

# Car Lighting Accounting

## ON THE ROCK ISLAND SYSTEM

On the Rock Island it has been necessary to devise some system of keeping track of car lighting equipments, such that exact information as to the cost and condition of any equipment can be furnished at any time on a moment's notice. In doing this, use has been made of the card index. The old style book records are more cumbersome and not nearly so handy for reference.

In the office of the Chief Electrician is a 5-inch by 8 inch file containing a card for every equipment. The form of this card is shown in Fig. 1. It is called the Daily Performance Card and the reports received from the various inspectors are entered on it usually the day after they are made out. These reports come in from all over the system. Regular electrical inspectors are located at Chicago, Rock Island, Council Bluffs, Kansas City, Denver, El Paso, El Reno and Los Angeles. It is the duty of these inspectors to look over all the axle-lighting equipments passing through their points and in case they are out of order to make repairs if possible. The inspectors are provided with transportation and can ride with the equipments as far as necessary to make repairs. In case the inspector does not have the time or materials it is his duty to report the difficulty to the next inspection point so that the inspector there may be ready to take care of it when the train arrives.

The form of the Daily Performance Report made out by the inspectors in shown in Fig. 2. These Reports go first to the Chicago repair shop in order that the Foreman of this shop may have the latest information as to the condition of the equipments. From there they are sent to the office of the Chief Electrician where the information on them is copied onto the filing cards which make up the permanent Daily Performance Record.

All important battery repairs are made in the Chicago shops. If incoming batteries are in poor condition they are removed from the cars and replaced with batteries from the Chicago Emergency stock. For this reason the battery instead of the car is the unit used in keeping the records of this shop.

The Battery Record file contains a 5-inch by 8-inch card for each set of batteries. This card is filled out when the battery is purchased and remains in the file until the battery is worn out or goes out of service. It forms a very complete record not only of the service of the battery but also of all materials used in its

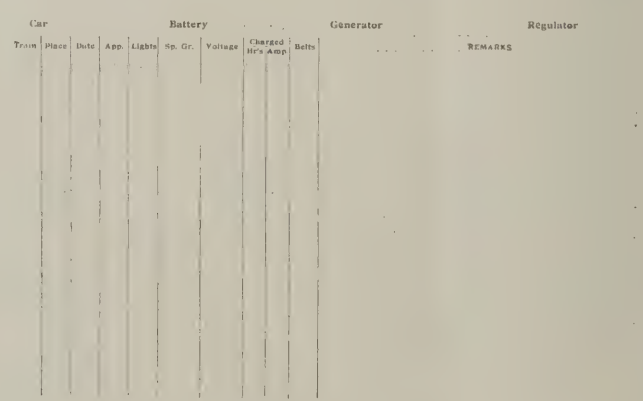



Fig. 1. Daily Performance Card.

maintenance. The front and back of this card are shown in Fig. 3.

In addition to this card file there is a wall list of batteries and their location. This consists of a number of small slots each ½ inch wide and about 6 inches long. In the left of these slots are placed slips of heavy paper about 4 inches long on which are written the numbers and descriptions of the different sets of batteries. In the right side of the slot is placed another slip of paper showing the location of the bat-

tery. This is either the name or number of a car, or "Chicago Emergency," which shows that the battery is being repaired or else is repaired and ready to be placed in service. When the battery men change the batteries on a car they simply shift the right hand slip. That is, if they substitute battery No. 10 for battery No. 3 on car No. 5, they take the No. 5 slip out of the slot containing battery 3 and place it in the slot containing battery 10, and change the "Chicago Emergency" slip from slot No. 10 to slot No. 3. This avoids the necessity for making any written record of the change, and the danger that it may be forgotten. When the battery changes are entered on cards the form shown in Fig. 4 is filled out and sent in to the office of the Chief Electrician. The list of battery repairs is left on a blackboard, from which it is transferred to the cards.

ROCK ISLAND LINES

DAILY PERFORMANCE REPORT OF ELECTRIC LIGHTED CARS

Station_____ 191__

| TRAIN NO. IN-OUT | NUMBER OR NAME OF CAR | Was Apparatus Working | Did Lights Full | Sp. Gr. of Pilot Cell | Height of Acid | Voltage | Charged Hr's Amp. | CONDITION OF Regulator | Generator | Bearings | Belts | MATERIAL USED | CAUSE OF FAILURE AND REMARKS | When Trouble Removed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

THIS REPORT TO BE FORWARDED DAILY TO THE CHIEF ELECTRICIAN, CHICAGO.

SIGNED_____ Inspector.

Fig. 2. Daily Performance Report Sheet.

DESCRIPTION AND RECORD OF BATTERY

Requisition No. _____ Inv. No. _____ Price _____

NO. _____ TYPE _____ SIZE OF PLATE _____ "H1+ ____ "W+ ____ "T ASSEMBLED IN CELL TRAY _____ R'B JAR _____ L'D TANK _____

NEW IN SERVICE _____ 19__ RATED CAPACITY _____ AMP. HR'S ACTUAL CAPACITY _____ AMP. HR'S

| DATE CLEANED | POS PLATES BKL'D | POS PLATES AV'G HI | HIGHT SEDIMENT | CONDITION ELEMENTS | CAPACITY TEST | GENERAL REMARKS | DATE | LOCATION APPLIED CAR | LOCATION APPLIED AMP. | LOCATION REMOVED DATE | LOCATION REMOVED CAR |
|---|---|---|---|---|---|---|---|---|---|---|---|

BATTERY MATERIAL CARD

| DATE | TRAY WOOD | LEAD NEW | LEAD RE'D | TANKS JARS | RUBBER SEP'R | RUBBER SHEET | RUBBER COVER | RUBBER BUSH'G | RUBBER TUBING | ELEMENT POSITIVE | ELEMENT NEGATIVE | ACID | CONNECTORS LONG | CONNECTORS SHORT | CONNECTORS HAND | CONNECTORS WIRE | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Fig. 3. Battery Record Card—Front and Back.

In the Chicago yards the first item of inspection is the gravity test. The Gravity Inspector goes through the cars as soon as they reach the yards. If the gravity is normal the equipment is probably in good condition, although further inspection may develop other troubles. Therefore the repair men go first to those cars with low gravity and look over the others later if they have time.

Every battery is overhauled at least once a year. At the first of every month a list of batteries to be overhauled is sent to the shop from the office of the Chief Electrician. Many of the batteries are overhauled more frequently as the rule is to take those in which serious trouble develops out of service immediately.

At the end of every month a report is made showing the number of belts lost during the month and the number of miles each has run. This is compiled from reports sent in from each division headquarters. A supply belt is kept on hand at each division point.

**BATTERY CHANGING CARD**

**Car No. _____ 19**

**Battery Removed _____**

**Battery Applied _____**

**Sp.Gr.Fully Charged _____**

**Date Cleaned _____**

**REMARKS:**

**Signature**

Fig. 4. Battery Changing Report Card.

The map (Fig. 5) shows the points at which electrical inspectors are located, indicated by solid circles, and the points at which car lighting belts only are kept on hand, indicated by open circles.

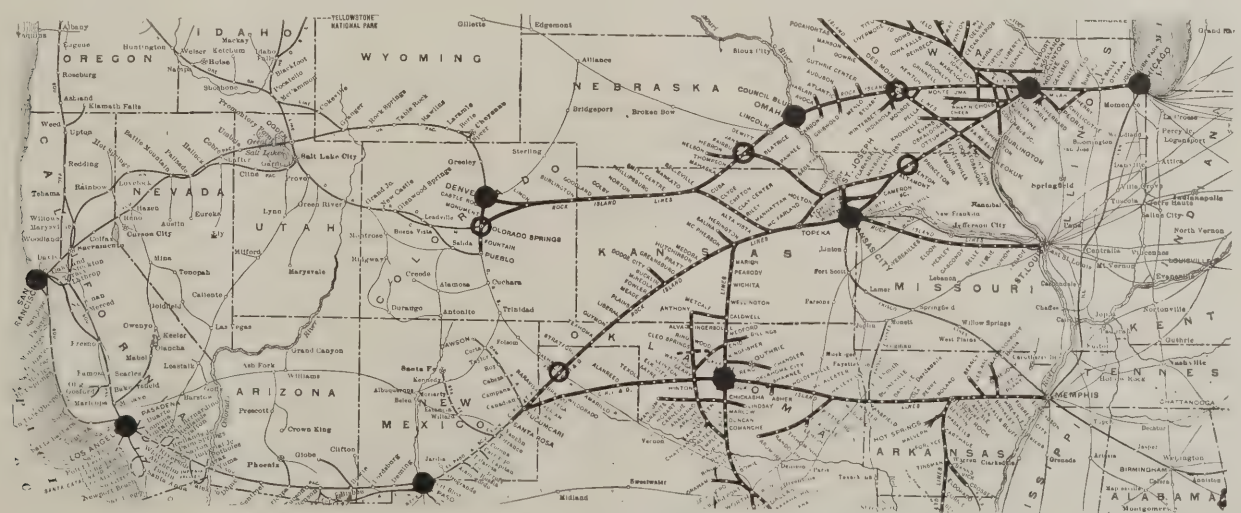



Fig. 5. Map Showing Location of Inspectors.

# The Care of Train-Lighting Batteries

S. W. EVERETT

Let us assume that the batteries have been put into commission according to the instructions of the makers, or have been received from the factory already set up, charged and presumably ready for service. In the latter case they should be carefully inspected to see that the voltage is correct and the electrolyte of the proper density. They should then be given a freshening charge of several hours at the normal rate.

The first care should be to see that the battery receives the proper charge. In looking after this we are confronted by two very different conditions. The first is where the axle device is used. The second is with straight-storage systems. The condition with the head-end system is in between. The reason these conditions are classified in this order is that charging with the axle device is without supervision, with the straight storage system under complete and continuous supervision, and with the head-end system under partial supervision.

### Charging Systems.

Batteries used in straight storage systems should be of sufficient size to carry the lamp load through the longest runs with a good margin for delays that may occur, and should be of a type capable of receiving a charge at a heavy rate. There are batteries of this type which can best be charged at the five-hour rate. Care should be used not to allow the battery to stand discharged for any length of time. In charging batteries on axle-systems it is necessary to accept a charge at an average rate, and that intermittently.

There are three different system of charging batteries on axle equipments: (1) Constant Current, (2) Taper charge, (3) Automatic stop charge. The system should be adapted to the battery or the battery to the system. Each battery is best adapted to one of these methods of charging. In all cases the batteries should be of sufficient capacity to carry the lamp load for 10 hours.

In theory the taper charge and stop charge devices are entirely automatic and regulate the charging current according to the voltage of the battery. In practice they do not work out quite so well and may cut down the charging current in spite of the fact that the battery voltage is not up to what it should be. Whatever the method of charging, constant care should be given to see that the voltage of the batteries and the specific gravity of the electrolyte is up to standard. I believe the pilot cell method is best for checking gravity.

When a battery comes in with an equipment out of order so that the gravity has been reduced, do not add strong acid in an attempt to raise the gravity. Charge the battery thoroughly and repair the equipment.

### Electrolyte.

After three to six weeks of service, if the batteries are sealed as all batteries should be, the electrolyte will be close to the top of the plates and a little too heavy. It is then time to flush with distilled water. Great care should be used to get "sure enough" distilled water—not condensed steam from boilers, nor melted ice, nor rain water from the top of a roundhouse.

When batteries are inspected they should be examined closely for loose connections. I favor a connector made of Okonite or Kerite plain rubber-covered cable, with lead terminals. Also that these terminals should be burnt directly on to the pillar posts without the use of brass bolts. This obviates the danger of the electrolyte being spoiled by corrosion of the brass likely to occur.

If the batteries are in a car in regular service, and the generator does not fail, they should require no attention except flushing for about 18 months, at the end of which time they should be cleaned according to the directions of the manufacturers. But belts come off, fuses blow, bearings wear out, commutators burn, pole-changers fail to work, brushes stick, or the car is set on a siding, and we have a discharged battery on our hands. This works no injury unless the battery is allowed to stand in a discharged condition for some time. Should this happen the battery will become sulphated and to get it into condition again this sulphate must be broken up.

### Loss of Capacity.

Sulphation can be cured by thorough charging either in the yard charging plant or on a run, providing the constant current system is used. I doubt very much whether a taper-charge or stop-charge device will permit enough current to flow to remove sulphation. The voltage of a sulphated battery is high, and these devices cut down the current as the voltage rises. (I had one set of 16 cells on an 8 hour rate of charge which showed a voltage of 2.3 volts to 3.9 volts, with 14 intermediate readings.)

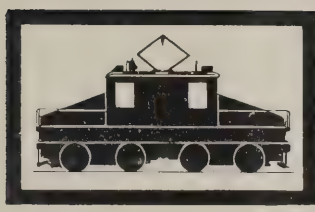
When pure water and pure acid have been used in the electrolyte the probable cause of loss of capacity is sulphation. Where the loss of capacity is serious the battery should always be removed from service and taken into the repair yards for thorough charging. There is a difference of opinion as to what is the correct rate for charging batteries. I believe we should follow the makers instructions. But charge them, and if in doubt, charge them again.

I favor the 8 hour rate perhaps for no other reason than that I use it with good results. In the case of the battery mentioned, I charged it about 85 hours at the 8 hour rate and after washing it and giving it another 14 hour charge I found it gave a capacity of more than seven hours at the 8 hour rate of discharge. Another battery which showed only 3 hours capacity after a 14 hour charge, was charged 72 hours and gave 6 hours capacity. After another 60-hour charge it showed 8 hours capacity, and after still another 60 hour charge, 8½ hours capacity.

Other causes of loss of capacity are short circuits and impurities in the electrolyte. Short circuits are usually caused by sediment filling up in the bottom of the containing jar or lodging between the plates. The remedy is the removal of the sediment. Impurities in the electrolyte can be detected by the color of the plates or chemical analysis. If in doubt it is always best to replace the electrolyte, and have the suspected electrolyte tested.

In about 18 months after a battery has been put into service it should be cleaned, and if wood separators are used they should be replaced. A careful capacity test should be made at this time and should low capacity be shown, unless plainly due to loss of material, an attempt should be made to restore the capacity by thorough charging.

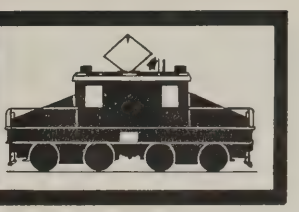
It may be that the wooden crates will have to be renewed oftener. I believe there is a better wood than oak for these crates. Yellow pine has given me excellent service.



# ELECTRIC TRACTION SECTION

EDITED BY

C. L. DE MURALT



The beginning of the New Year and the starting of the new Traction Department present a fit opportunity for a general review of the electric traction situation.

In considering the electrification of any given railway there are really two entirely separate questions that want to be answered.

The first is: "**Why** shall we electrify?" and the second is: "**How** shall we electrify?"

Of course it sometimes happens that the best answer to the first question is: "Don't electrify at all." If that's the case, it relieves us from answering the second question and the best thing we can do in such instances is to drop the electric idea right then and there.

But there are plenty of instances where electrification is distinctly advisable.

Sometimes the strong arm of Law makes us do it. Other times we want to be nice to our passengers and wish to make their trip through a tunnel as agreeable as possible.

Both may be termed electrifications for theoretical or ideal reasons.

In other cases we may have a terminal station which is very much crowded and where it is difficult to get trains in and out fast enough with steam engines, or we may have a heavy grade where the limited tractive power of the steam locomotives places restrictions on the amount of traffic that can be handled.

In such cases electrification is advisable for practical or operating reasons.

We abstain wisely today from mentioning the possibility of introducing electricity for the savings which it will make as compared with steam operation.

Time has not yet sanctioned its use for economical or financial reasons. But all available data point to the likelihood that the more we come to understand the matter the more will we be interested in the economical side of the question.

Taking it for granted that electrification has been decided upon for a certain section of a given railroad, there still remains the problem of how best to do it.

During the past few years we have heard grave arguments in favor of a great many particular electric systems, some good, some bad, others indifferent. The trouble is that the parties to the discussion were often not satisfied with proclaiming the advantages of their particular pet, but they frequently attacked all other systems. Some went as far as to assert that no real progress could be made in railroad electrification until one single system is chosen as a universal standard. Naturally they expected their system to be adopted for the purpose.

All this has raised quite an unnecessary noise and has distinctly beclouded the situation.

The truth is that each system of electrification has its advantages and also its defects. None of the systems has thus far shown so marked a superiority over all the others as to make it universally desirable. There is no need at all for a universal standard. It is just as easy to use different types of electric locomotives on one or on several railroads as it is to use different types of steam engines. In fact, there are marked advantages connected with such practice, and all that should be standardized is such things as clearances, contact devices, etc.

**It may therefore be laid down as an axiom that every individual case of electric traction should be investigated and treated entirely by itself and on its own merits if the best results are to be obtained.**

In a general way, the following three systems may be said to be best suited for the conditions as usually encountered on American railroads: the continuous current or direct current system*, the single-phase alternating current system, and the three-phase alternating current system. In certain cases storage battery cars or locomotives will doubtless also prove useful.

Of the three first named systems the direct current one is the oldest. It has been thoroughly developed and perfected in every little detail, and the manufacture of all its parts has been so thoroughly organized through years of patient endeavor that it is today on a thoroughly commercial basis and can be produced at a very low cost.

There is no reason for considering anything but the standard 500 to 700 volt direct current equipment for any road which operates single cars or medium weight trains over distances not exceeding, say 15 or 20 miles, especially if the conditions resemble those of city street railway traffic.

But when we come to deal either with longer distances or with heavier trains, or with a combination of the two, then the standard direct current system will no longer fill the bill. Either a higher pressure direct current system must be used—and in Europe experiments in this direction have been carried very far—or else one of the two alternating current systems must be resorted to.

So long as traffic is dense enough to make the distance between consecutive cars or trains comparatively small, the direct current system with suitably high pressure can probably hold its own.

With cars or trains few and far between the alternating current systems gain in favor.

When single cars or combinations of a few cars only are used the single-phase alternating current system shows advantages.

For heavy trains, and more particularly when heavy grades are involved, the three-phase alternating current system is supreme.

But generalizing of this nature is dangerous and the only true course to take is, as has already been pointed out, to treat each problem individually, and by painstaking investigation and careful comparison of actual values to establish which system presents the greatest merits for any given case. The more this will be done the quicker will the mist disappear from the scene and the more convincing will the general advantages of electricity appear to those who are now watching all things electrical with a certain amount of mistrust.

C. L. DE MURALT.

Ann Arbor, Mich., December, 1910.

*The two names, continuous current and direct current, as used in America, cover one and the same thing. The term continuous current seems to be the more scientifically correct of the two. It is used exclusively by English engineers and is also approved by the Standardization Committee of the American Institute of Electrical Engineers. General American usage, however, has sanctioned the shorter term, direct current, and in deference to the general custom we will until further notice also use this term.

# Detroit Tunnel Electrification

## OF THE MICHIGAN CENTRAL RAILROAD

Without any particular ceremony or formality the electrically operated Detroit River Tunnel of the Michigan Central Railway between Detroit, Mich., and Windsor, Ont., was put into service recently.

On September 18 the railway company began running regular freight trains through the tunnel. A few days later followed express and mail trains, and the traffic was increased gradually until on October 16 all trains were sent through the tunnel and on the same day the car ferries on the river were taken out of commission.

The July, 1909, number of RAILWAY ELECTRICAL ENGINEER contained an article descriptive of the electric locomotives used in this work and it is due

Fig. 1. Interior of Tunnel.

to the thorough trying out of these engines and of all other parts of the electric equipment that the starting of the electric operation was so smooth and without any hitches of any kind.

The engineers who run the electric trains are all former steam engineers. As a matter of fact they are all picked men taken from the honor rolls of the company. They were selected, not so much for any particular knowledge which they possessed of things electrical, but rather for long experience in the careful handling of trains, and for such qualifications as calm judgment coupled with resourceful and instant action in cases of emergency. Under a special agreement with the Brotherhood of Locomotive Engineers these men were given a thorough training in the handling of electric trains before they were put into service.

Although it does not take more than one man to actually run a train, and he can control all the movements of the train by means of the controlling devices within easy reach of his arm, yet there are always two men on each locomotive as required by the Interstate Commerce laws, so that they may assist each other in cases of trouble.

The energy for the operation of the trains is fur-

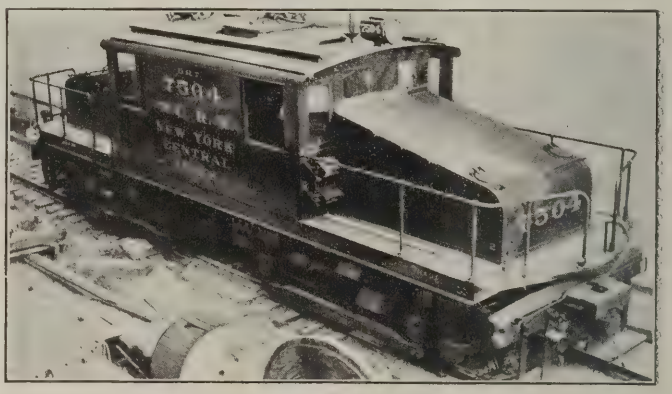



Fig. 2. Locomotive No. 7504.

nished by the Detroit Edison Company and is delivered to a sub-station on the Detroit side of the river, right close to the foot of the westbound grade. It is delivered to the sub-station in the form of 4400-volt three-phase alternating currents and is there trans-

Fig. 3. First Train Emerging from Tunnel.

formed into 650-volt direct current for use on the third rail.

The energy is bought on a very interesting basis. The contract provides for a low price, but it stipulates that the load must be practically constant and must be

kept within certain well defined limits above and below a fixed normal amount.

This is a very serious stipulation, for a railway whose load is naturally of a highly fluctuating nature, but the condition was successfully met by the use of a storage battery and booster in connection with a very ingenious regulating or governing device. The sub-station contains two motor-generator sets, each of 1,000 kilowatt normal output, or capable of furnishing 1,540 amperes each. The storage battery is rated at 3,480 amperes for one hour, but it can momentarily give up to 7,250 amperes. One of the motor-generators is always kept in reserve. The other is run at fixed output continuously. If there is not much load on the line the generator will charge the battery. If the train load exceeds the capacity of the generator the battery will discharge and take care of the excess load.

When bids were called for the electric equipment of the Detroit River Tunnel it was thought advisable to call for tenders on a separate power house for the railway company. It was soon found out, however, that the purchasing of energy from the Detroit Edison Company on the above basis was cheaper and at the same time made possible a decrease in first cost of installation. It also places the tremendous reserve capacity of the Edison power plant at the disposal of the railway company and thus practically insures continuity of energy supply without any extra charge.

The sub-station is connected with the switching towers, and these with the third rail, by means of underground cables laid in conduits. All told there are about 36 miles of electric cables of various kinds, most of them being of 1,000,000 circular mils cross section, or about the largest size that is manufactured.

Inside the tunnel the cable conduits are placed in the walls and a sort of bench is thus formed, which is clearly to be seen in Fig. 1, representing an inside view of the finished tunnel. These benches, built of concrete, afford at the same time a safe passageway for the trackmen and an exit from the tunnel. Their top is 2½ feet wide and about 5 feet above the rails. To reach them from the rails there are iron ladders staggered every 25 feet in the walls and embedded flush in the concrete.

The third rail, plainly visible in Fig. 1, is of 70-pound section and of the inverted and protected Wilgus-Sprague type, which was first used in the New York City electrification of the New York Central lines.

There is also a 6-inch water main running through each tube of the tunnel from portal to portal, with hose connections every 200 feet, and a complete fire alarm system with boxes every 200 feet in each tube.

Field telephones, compactly built in metal boxes and placed at convenient points, provide quick communication with the sub-station.

The tunnel lighting is by means of incandescent electric lamps placed every 20 feet and hooded against the direction of the trains so as not to blind the engineers.

To keep the tunnel dry there are ten electrically driven pumps for the discharge of all water from five tunnel sumps.

The electric locomotives here used are of the double truck type and of the 0-4-4-0 class. Two of these, operated by multiple unit control as one machine, are used for the heavy freight trains, being designed to handle an 1800-ton train at 10 miles per hour up the grade.

Fig. 4. Detroit Tunnel Locomotive No. 7500.

Each engine has a weight of about 100 tons distributed over eight 48-inch driving wheels.

Fig. 2 shows one of these locomotives, No. 7504, on the grade after emerging from the tunnel, and Fig. 3 shows the first regular express train, No. 31, as it went through the tunnel on September 25, 1910.

The total length of the electrically operated line is about 6 miles, containing about 19 miles of single track electrically equipped. The tunnel proper is 7,860 feet long from portal to portal, of which about 2,620 feet are directly under the river.

On the Detroit side the summit of the slope is a little less than a mile from the river, on the Windsor side it is about a mile and a quarter. The gradients are not the same on the two approaches, the eastbound one having a grade of 1½ per cent. and the westbound one of 2 per cent. The reason for this is that the eastbound traffic is much heavier than the westbound traffic, the latter always comprising many empty cars.

Block signals for the safe operation of trains are placed 400 feet from the portals and at the two summits. An arm at "caution" gives the right to advance to the next block. An arm at "clear" gives the right to proceed to the summit of the slope on the other side. There is a constant inspection of tracks and equipment to insure regular and fast service through the tunnel.

At an average speed of 20 miles an hour in the tunnel, the passage from one summit to the other is made in about eight minutes. The Detroit River Tunnel cuts off more than half an hour from the schedules of fast limited and express trains between the East and West, and it effects a saving of from three to twelve hours in the case of through freights.

It has reduced the cost of handling the immense traffic flowing across the border at the Detroit Straits at least 75 per cent.

The tunnel, switching yards and new passenger station in Detroit are estimated to cost, when the work is entirely completed, not far from twenty million dollars. Of this the electric equipment, including electric locomotives, required quite a little less than one million dollars.

In a future issue we expect to take up the question of cost in greater detail and compare the three different systems that had been proposed for this installation on a cost basis.

## DETROIT TUNNEL LOCOMOTIVES.

A detailed description of these locomotives was printed in the RAILWAY ELECTRICAL ENGINEER for July, 1909. A short review of their electrical features is appropriate at this time.

The locomotives are designed for hauling both passenger and freight trains through the tunnel, and for switching in the yards. They are the most powerful direct current locomotives ever built.

The motor equipment consists of four 300 h. p. commutating pole motors. The gearing between the motor and the axle has a 4.37 reduction. The driving wheels are 48 inches in diameter. Each motor will develop a tractive effort of 9,000 pounds, which gives the locomotive a tractive effort of 36,000 at a speed of 12 miles per hour.

The motors have an overload capacity sufficient to slip the drive wheels. At the point of slipping they develop an instantaneous traction effort of over 50,000 pounds. The maximum speed of the locomotive is 35 miles per hour.

Forced ventilation is furnished the motors by a blower, which has a capacity of 2,000 cubic feet of air per minute. This air passes around the field coils.

The control system used is the Sprague-General Electric multiple unit type, with two master controllers in the cab and contactors in the auxilliary cab. If necessary, three locomotives can be coupled together and operated in unison.

The control combinations are so arranged that the motors can be operated four in series, two in series and two in parallel, or four in parallel. There are nine resistance steps in series, eight in series-parallel, and seven in parallel.

## GRAND TRUNK RAILWAY TO ELECTRIFY LINES IN MONTREAL.

It has been announced that plans for elevating the tracks of the Grand Trunk Railway from the Bonaventure station of the company in Montreal to St. Henri have been prepared for submission to the Board of Railway Commissioners at a meeting to be held in Montreal shortly.

These plans embrace a scheme for handling all traffic within the city with electric locomotives.

Steam engines are to be detached from trains entering Montreal from the East at St. Lambert and from the West at St. Anne's.

It is proposed to secure power from St. Timothy, where the plant of the Canadian Light and Power Company is situated.

It is stated that the Grand Trunk Railway will apply to the Dominion Parliament at the present session for authority to raise funds for this electrification.

In view of the relatively short distance involved and of the suburban character of the service the use of the direct current system has been recommended.

## TEST OF EDISON STORAGE BATTERY CAR.

A large two-truck Beach car originally built by the Federal Storage Battery Company for the South Shore Traction Company for use in its service across the Queensboro Bridge, New York, and fitted with Edison storage batteries, has been thoroughly tested during the past few weeks on the Erie Railroad in the neighborhood of Orange, N. J.

Quite a number of prominent railroad officials and engineers were present at various times during these tests, including F. D. Underwood, president of the Erie Railroad. In fact, it is said that these tests were made especially to give the officials of the Erie an idea as to the suitability of this type of car for service on some of the branch lines where traffic is light.

It is stated that the performance of the car under various weather conditions exceeded the expectations of its makers. The car made a higher speed than had been promised for it, and it was operated at a less expenditure of energy than had been estimated.

Be that as it may, we understand that the car has been put into regular service upon the Erie Railroad and is now being operated on the Orange branch, where it makes three trips daily between West Orange and Forest Hill.

This experiment will doubtless be watched with great interest by many and we hope before very long to bring some data regarding the behavior of this car in continuous running and regarding the actual cost of this kind of service.

## STEAM ROAD IN SOUTHWESTERN NEW YORK WANTS TO ELECTRIFY.

The Jamestown, Chautauqua and Lake Erie Railroad Company, which is really a part of the Buffalo and Lake Erie Traction Company, has made application to the Public Service Commission of the Second District of the State of New York for permission to electrify its line.

It extends from Jamestown to Westfield, N. Y., a distance of about 28 miles. Thus far it has been operated exclusively by steam locomotives.

At Westfield the road connects with the Buffalo and Lake Erie Company's line, which is already electrically operated by the use of energy from Niagara Falls. It is, therefore, more than likely that the new line will obtain its motive power from the same source, though nothing definite is yet known on this subject, nor regarding the electric system to be employed by the Jamestown, Chautauqua and Lake Erie.

## CHICAGO TERMINAL ELECTRIFICATION.

The Chicago Association of Commerce, composed of representatives of many large industries, has asked the Mayor to appoint a committee to confer the Association's committee on the electricfication of the railroad terminals in Chicago. The latter committee is said to be composed of engineers who have studied the project and reported it entirely feasible.

The action in the Council was in the form of an ordinance requiring the railroads to electrify all tracks within 7 miles of the City Hall before Jan. 1, 1913. This ordinance was referred to the Council's committee on transportation. It seems likely that some definite action will be taken in the near future.

# SHOP SECTION

EDITED BY

GEO. W. GRAVENS

## CONTINUOUS CURRENT MOTOR SPEEDS.

When choosing continuous or direct current motors for any special service, requiring constant speed at a definite R. P. M., speed regulating rheostats with a large number of divisions of resistance should always be installed. This is important because it is impracticable to make a motor which will run at its rated speed under all conditions.

This is not hard to understand, as, in addition to the variations due to load, temperature and brush position, there will be inherent differences in various motors of the same design. Motors made from the same drawings and specifications will run at slightly different speeds due to variations in the magnetic qualities of the iron, the resistance of the conductors and dimensions of both rough and finished parts. In other words, unavoidable differences in manufacture will affect the characteristics of each motor.

Continuous current motors are built for stationary service with fields wound and connected in one of three ways, series, shunt or compound, so let us consider this matter of speed in accordance with these divisions.

### Series Wound Motors.

The speed of series wound motors depends upon the load, and varies through such a wide range that controllers with heavy capacity resistances are necessary. Such motors are seldom used where accurate, constant speeds are wanted, though for railway and hoisting they are good on account of their high starting torque and overload capacity.

The effect of changing the voltage is greater in series motors than with either of the others. For instance, if the voltage impressed on a series motor is lowered the speed will drop in a great proportion (with current and torque the same as before), and, if the same amount of work is to be done at the lower voltage the speed will drop still more, because greater torque and current are necessary than at the higher voltage. With a shunt wound motor the reduced voltage tends to reduce the armature speed, whereas the weakened field tends to increase it slightly (but in a lesser degree), so the actual speed will be the resultant of these opposing influences.

The speed of series motors is also less when hot than when cold, on account of the increased resistance of the windings, but the difference is usually too small to consider. Still, series motors are rated higher for intermittent service than for continuous work, although the speed will be lower at the increased rating, so this should always be taken into account.

### Shunt Wound Motors.

Motors with shunt fields run at higher speeds when hot than when cold (just the opposite to series motors), because of the weakened field due to increase of resistance with temperature. The increase of speed will be about 5 per cent, and the maximum is usually reached in about two hours of continuous operation.

It is hard for manufacturers to make motors which will run to within 3 per cent of normal speed, above or below, and the speed of shunt motors drops from 2 per cent to 5 per cent with increase of load, so we may have considerable variation in speed between motors of the same design. Taking into account the differences in manufacture we may have speed differences of 16 per cent or more.

For example: A motor with full load speed 3 per cent low when hot, and with characteristics causing 5 per cent drop with increase of load, might have a full load speed of 8 per cent low when running cold. Another motor of the same design but having a full load speed 3 per cent high when cold, might have a no load speed 8 per cent high when hot. This gives us a total difference of 16 per cent in speed between the two motors, even though they are intended to be identical.

These variations can be reduced, of course, by shifting the brushes on the commutators (in the direction of rotation to reduce the speed or against it to increase the speed), but this is not good because it tends to increase sparking. A much better way is to make special provisions for getting motors which do run at the same speed under similar conditions. This can be done by selecting motors which come within the desired limits, by using field rheostats (the common way), or by having the fields specially wound to suit the conditions.

### Compound Wound Motors.

The third class, motors with compound wound fields, are a combination of series and shunt motors as to both winding and characteristics. They will not run away at no load (as series motors may do when not properly controlled) on account of the shunt winding on the field, although the speed drops slightly under increased load. They start with a higher torque than shunt motors, however, on account of the series winding on the fields. Motors of this class operate more economically and smoothly with flywheels, as the wheels can take up a part of the load when the speed drops.

Some motors of this class drop as much as 15 per cent below normal speed at full load, whereas others will show an increase of 15 per cent above normal at no load, running at rated speed at full load. Thus we find it to be necessary to have full knowledge of both the motors and the operating conditions before we can insure a given speed.

This should not be taken to mean that electric motors are very unreliable devices, for extreme cases have been mentioned here to illustrate the point, but rather that the electrical engineer of a railroad, or other corporation, should be alive to the fine points of his business in order to give satisfactory services and to grow with the possibilities of his position.

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## A NOTABLE RAILROAD SHOP ELECTRIFICATION.*

During the past decade the use of electric motors for driving machine tools in railroad machine shops has become quite common, but when a shop is so completely equipped as that of the N. Y., N. H. & H. R. R. at Readville, it becomes worthy of special notice.

This entire plant is operated by alternating current, at 25 cycles, the only continuous current being that

*The data regarding this installation was taken from an article by A. I. Totten in *General Elecrtic Review.*

generated by the exciters for the fields of the alternators.

There are 173 induction motors installed, with a total capacity of 3,160 H. P., although the average motor load at the switchboard is only from 800 to 900 H. P. With the lights included the load runs from 1,050 to 1,200 H. P., showing that the average total load equals only about 30 per cent of the total capacity of the motors installed. Consequently the power factor is low, being around 69 per cent during the day and increasing about 3 per cent when the lights are operating.

The power plant contains six 400 H. P. Babcock & Wilcox boilers; three 400 K. W. General Electric generators, direct connected to Hooven-Owens-Rentschler engines; two 50 K. W. exciters driven by Watertown engines; three motor driven 12-B Brush arc generators; three Franklin air compressors, and a switchboard composed of 24 blue Vermont marble panels, including a voltage regulator. The entire plant operates at 550 volts and most of the motors run at 750 revolutions per minute.

The main building of the Readville shops is 904 feet 6 inches long and 150 feet wide. It is divided longitudinally into two equal parts, one side containing the 600 foot erecting shop and the 300 ft boiler shop, the other containing the machine shop and the tank shop. In the latter half of the building there is a 35 foot gallery running full length, where such light work as electrical repairs, brass, tin and copper work, etc., is done. On the ground floor the main machine shop is 600 feet long, with the lighter machinery under the gallery and the heavier machines in the main aisle, where they may be served by the overhead cranes. Jib cranes are also mounted near the more important machines for convenience in handling material.

Other features of these shops will be described in futures issues of this paper, and descriptions of other shops will also be given from time to time, special emphasis being laid upon the electrical features.

Turning now to the motor driven machine tools we find they comprise every kind used in railroad shops, and several sizes of each kind. Tests made on a large number of these machines showed that the large sized motors were justified, on account of the power required at certain times during operations, although the average power required was very much below the normal capacities of the motors. With few exceptions these motors are all of the "squirrel cage" type, the others being polar wound with variable resistances for starting.

The tests which follow were made with the machines running under average conditions, and agree quite generally with the statements made in an article published in the March, 1910, issue of this paper.

Inspection of the accompanying test records will show how much momentary overload is put on the motors at such times as reversing the direction of travel of planer beds, punching, steel plates, etc., and brings out clearly one of the advantages of the electric motor for such service.

**80 IN. DOUBLE WHEEL LATHE (PUTNAM), 10 H. P. MOTOR**

| Load | Kilowatt Input |
|---|---|
| Rolling axle, speed 15 feet per min. | 0.5—2.0 |
| Turning axle, 1/64 in. cut, 1/32 in. feed, speed 15 ft. per min. | 0.6—1.6 |

**50 IN. DOUBLE WHEEL LATHE (PUTNAM), 50 H. P. MOTOR**

| | |
|---|---|
| Running light | 2.4 |
| Full load | 28 |

Load consists of two heavy cuts on driving wheels, ⅜ in. feed, ⅜ in. cut, cutting speed 12 ft. per min. Kind of tool steel—Mushet high speed.

**7½ H. P. MOTOR USED TO MOVE TAIL STOCK**

| | |
|---|---|
| Moving forward | 1.8 |
| Moving backward | 1.8 |

**600 TON, 90 IN. WHEEL PRESS (POND), 25 H. P. MOTOR**

| | |
|---|---|
| Running light | 1.4 |
| Pressing 6 in. crank pin from driving wheel | |
| Average load | 2.3 |
| Maximum load when pin started | 3.5 |

Maximum pressure when pin started, 260 tons.

**36 IN. X 12 FT. PLANER (PUTNAM), 10 H. P. MOTOR**

| | |
|---|---|
| Running light | 1.8 |
| Forward, no load | 2.8 |
| Reverse | 22. |
| Back | 4.4 |
| Reverse | 18. |
| Forward under load | 3.6 |

Load: One 1/64 in. cut, 1/16 in feed on cast iron. Tool steel, Midvale. One 1/32 in. cut, 1/16 in. feed on steel. Tool Steel, Syrian. Forward 35 ft. per min. Backward 70 ft. per min.

**48 IN. X 16 FT. DOUBLE PLANER (WOODWARD & POWELL), 25 H. P. MOTOR**

| | |
|---|---|
| Running light | 2. |
| Forward, no load | 4. |
| Backward, no load | 4. |
| Forward, under load | 13. |

Load, two 5/16 in. cut, 1/32 in. feed on cast steel.
Tool steel—Mushet high speed.
Cutting speed—45 ft. per min.

**72 IN. X 12 FT. PLANER (POND), 25 H. P. MOTOR**

| | |
|---|---|
| Running light | 1.7 |
| Reverse | 20. |
| Forward, no load | 2.4 |
| Backward | 5. |
| Reverse | 10. |
| Forward, under load | 4.8 |

Load, 1 cut ½ in. with ⅛ in. feed on cast iron.
Tool steel—Mushet high speed.
Cutting speed—18 ft. per min.
Return feed—54 ft. per min.

**72 IN. X 30 FT. PLANER (PUTNAM), 35 H. P. MOTOR**

| | | |
|---|---|---|
| Running light | 3.4 | |
| Forward, no load | 4.8 | |
| Reverse | 32. | 5 tons |
| Backward | 9.2 | on bed |
| Reverse | 14.8 | |
| Forward, under load | 6.4 | |

Load, one ¼ in. cut, 1/16 in. feed on cast iron.
Tool steel—Mushet.
Speed forward—30 ft. per min.
Speed backward—65 ft. per min.

**CYLINDER BORER, 7½ H. P. MOTOR**

| | |
|---|---|
| Running light | 0.76 |
| 3 cuts ⅛ in by 1/16 in. feed | 4.8 |
| 5 cuts ⅛ in. by 1/16 in. feed | 5.6 |

On 3 cuts, cutting speed 17 ft. per min. Tool steel unknown.
On 2 additional cuts, cutting speed 25 ft. per min. Tool steel, one Mushet high speed; one Syrian.

**6 FT. RADIAL DRILL (BICKFORD), 5 H. P., 1500 R. P. M., MOTOR**

| | |
|---|---|
| Running light | 0.9 |
| ⅞ in. hole in cast steel | 1.9 |

Feed—½ in. per min.
Speed of drill, 74 r.p.m.

**5 FT. RADIAL DRILL (BICKFORD), 5 H.P., 1500 R.P.M. MOTOR**

| Load | Kilowatt Input | Speed of Drill |
|---|---|---|
| Running light | .48 | |
| One ⅝ in. hole in steel, feed 0.45 in. per min. | 1.3 | 52 r.p.m. |
| Two ½ in. hole in cast iron, feed 0.16 in. per min. | 1.5 | 24 r.p.m. |
| Two ¾ in. hole in steel, feed 0.375 in. per min. | 2.4 | 20 r.p.m. |

**51 IN. BORING MILL (BULLARD), 7½ H.P. MOTOR**

| | |
|---|---|
| Running light | 1.8 |
| Two ¼ in. cuts, 3/32 in. feed, 40 ft. per min. on cast iron | 4.6 |

Tool steel—Mushet high speed.

**47 IN. BORING MILL (BAUSH), 10 H.P. MOTOR**

| | |
|---|---|
| Running light | 1.9 |
| One 7/32 in. cut, 1/32 in feed, 35 ft. per min. cast steel. | 3. |
| One 3/16 in. cut, 3/64 in. feed, 40 ft. per min. cast steel. | 3.5 |
| One 3/16 in. cut, 1/16 in. feed, 50 ft. per min. cast steel. | 4. |

Tool steel—Mushet high speed.

**BUFFER AND GRINDER (RAWSON), 3 H.P. MOTOR**

| | |
|---|---|
| Running light | 0.4 |
| Grinding 6 in. steam pipe to surface | 0.5 |

**COLD SAW (NEWTON), 3 H.P. MOTOR**

| | |
|---|---|
| Running light | .6 |
| Cutting 6 in. cast iron | 3.2 |

Slow feed, 0.45 in. per min.
Saw 16 in. diam., 14½ r.p.m.

**FLUE CLEANER (RYERSON), 25 H.P. MOTOR**

| | |
|---|---|
| Rolling | 7.2 |
| Lifting | 17. |

Loaded with 308— 2 in. diam. tubes, 12 ft. long.

**NO. 5 PUNCH (HILLES & JONES), 5 H.P. MOTOR**

| | | |
|---|---|---|
| Running light | 0.7 | |
| Punching 9/16 in. hole in ¼ in. boiler plate | 1.3 | Max. |
| Punching 9/16 in. hole in 3/16 in. boiler plate | 1.2 | |
| Punching 9/16 in. hole in 5/16 in. iron | 1.5 | |
| Punching 9/16 in. hole in ½ in. steel | 2.32 | |

22 punches per min.

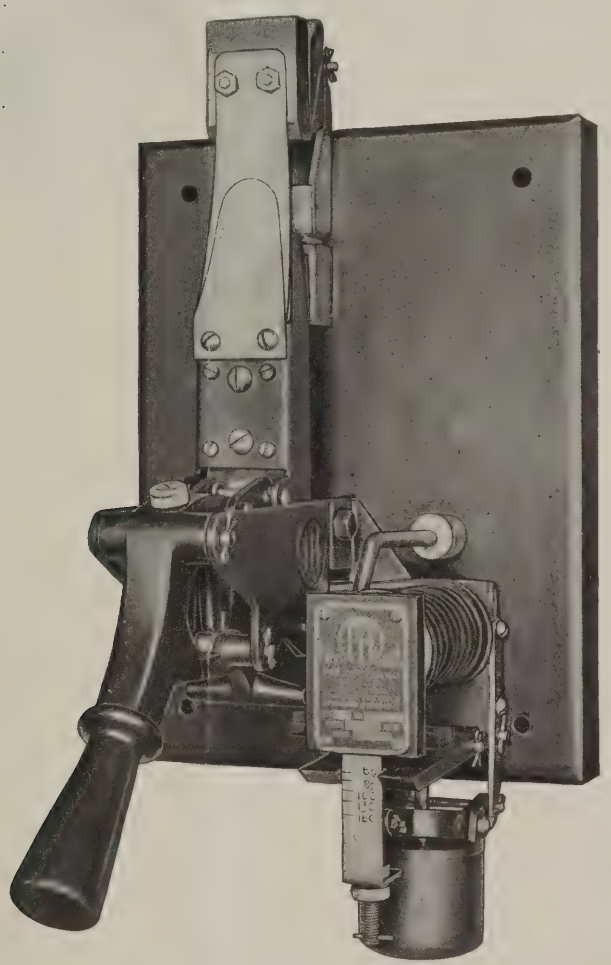
**NO. 4 PUNCH (HILLES & JONES), 10 H.P. MOTOR**

| | | |
|---|---|---|
| Running light | .5 | |
| Punching 13/16 in. hole in ½ in. flange steel | 4. | Max. |

# Direct Acting Time Limit Circuit Breakers

The circuit breaker as ordinarily made responds immediately to overload or short-circuit, and where the overload is suddenly applied, the circuit breaker frequently opens before the ammeter has time to indicate the volume which the current attains. While in many cases this immediate action is necessary in order to secure effective protection, there is, nevertheless, a legitimate demand for a circuit breaker which will be responsive to overloads only after they have been maintained for an appreciable period of time.

Without going into details of the Time Limit Circuit Breakers, which have hitherto been placed upon the market, it may be stated that, almost without exception, they involve the use of spring motors or relays. Methods employing such devices are obviously indirect, and introduce into the operation of the circuit breaker a number of intermediate steps, failure in any one of which results in failure of the circuit breaker to perform its function.



Time Limit Circuit Breaker.

The breaker shown in the cut shows clearly the extreme simplicity of the Direct Acting Time Limit mechanism.

The cylindrical vessel immediately below the housing contains a seat for a circular disc, which is suspended from the armature co-operating with the restraining latch. The engaging faces of the disc and its seat are accurately surfaced, and the disc is supported in such a manner that it may perfectly align itself with its seat. The disc, when seated, is surrounded with a shallow bath of oil, serving to exclude air from between the engaging faces, which are thus separated only by a thin film of oil. It is obvious that the intimate engagement of the disc with its seat causes an additional restraint upon the armature proportional to the total pressure of the atmosphere upon the upper surface of the disc.

In the event of overload, the pull of the armature communicated to the disc causes gradual extension of the oil film, until if the overload be sufficiently long continued, the film is finally ruptured, the disc is suddenly released and the armature, which now moves forward without restraint, causes the opening of the circuit breaker in the usual manner. While the force necessary to rupture the oil film is very considerable, the movement required is almost microscopic, a fact which contributes greatly to the accurate working of the device. The principle here involved can best be appreciated by contrasting the Direct Acting I-T-E Time Limit with other forms in which the time function is secured by exerting restraint upon the armature throughout an extended movement, thus causing it to do work as it advances under the action of the overload. As the armature advances into the magnetic field, less and less current will be required to sustain its movement; a brief overload may, therefore, bring the armature into a position where its movement will be continued by very much reduced current, and thus the circuit breaker may be opened with a current much less than that for which it is set. This action may aptly be designated as "creeping." Contrasted with this, the movement of the armature of the "Dalite" while under restraint is negligible, and the strength of the magnetic field is consequently unaffected thereby; hence, "creeping" is impossible.

To separate the disc from its seat, a certain definite amount of work must be done; the stronger the pull communicated by the armature to the disc, the more quickly this work will be accomplished, and the more promptly the circuit breaker will be opened. The time element is, therefore, inversely proportional to the pull of the overload magnet, which in turn is proportional to the square of the current. As a result of these conditions, the time required to cause the opening of the breaker is, broadly speaking, inversely proportional to the square of the overload current or directly proportional to its heating effect.

For larger types of circuit breakers, such as are employed to protect generators and large motors, the I-T-E Direct Acting Time Limit is made adjustable for different periods of time. This is accomplished by reducing the contact area of the disc with its seat, by slight depressions extending over a portion of each surface. When the seat is turned so that these depressions are opposed, the surfaces engage over a maximum area; angular movement of the seat from this position, thus displacing the depressions with reference to each other, causes proportional reduction in the area of engagement. The seat may be turned by a small knob, which moves over a scale upon which the relative time calibrations are indicated. The overload setting is effected in the usual manner, by moving the armature toward or away from the magnet as the current at which the circuit breaker is required to operate is to be increased or decreased.

# The 1910 Edison Storage Battery*

WALTER E. HOLLAND

The above title refers to the "A" type Edison battery, which was actually brought out in 1908, and which with slight improvements is now being manufactured in large quantities at the factory in Orange, N. J. As this battery has been fully described in the publications of the Company and in various magazines, no time will be given to further descriptions here, except to say that at present five sizes of cell are being marketed: "A4," "A6," and "A8" for automobiles, street cars, car-lighting, industrial engines, and so forth; and "B2" and "B4," small cells rated at 40 and 80 ampere-hours, respectively, for ignition and other light work.

The "A4," "A6," and "A8" cells are identical in construction, differing only in the number of plates; the "B2" and "B4" contains plates one-half the regular

| | "A4" | "A6" | "A8" |
|---|---|---|---|
| Outside measurement of can in inches | 2 9-16x 5 1-8x12 3 8 | 3 3-4x 5 1-8x12 3-8 | 4 7-8x 5 1-8x12 3-8 |
| Height to top of pole in inches | 13 3-8 | 13 3-8 | 13 3-8 |
| Weight of complete single cell in pounds | 13 34 | 19.00 | 25 00 |
| Pounds per cell of a standard assembled battery | 14 21 | 20.09 | 26.15 |
| Normal discharge rate in amperes | 30 | 45 | 60 |
| Average voltage at normal rate | 1 2 | 1.2 | 1.2 |
| Rated ampere-hour output | 150 | 225 | 300 |
| Rated watt-hour output | 180 | 270 | 360 |

Fig. 2. Types—Dimensions—Ratings.

height, but in other respects are similar to the regular type. For most purposes cells are mounted in wood trays having hard-rubber insulation fittings, as shown in Figure 3.

### Testing Methods and Notes.

Before proceeding with the presentation of results of tests, which is the purpose of this paper, a few

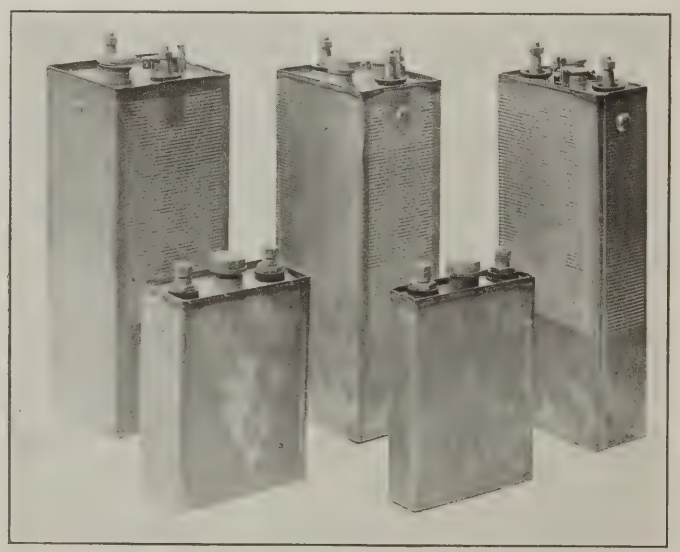


Fig. 1. Various Sizes of Edison Cells.

words are necessary regarding methods and testing arrangements.

The battery testing department of the Edison Laboratory is run twenty-four hours daily, and tests are made consecutively with very little rest between. Consequently the results are conservative, it having been found by experiment that slightly higher results are obtained if cells, after discharge, are allowed to stand long enough to cool, thus also allowing the electrolyte to equalize in the plate pores by diffusion. Cells are usually tested in groups of three or four and the average result taken; but sometimes when readings must be gotten quickly or at very frequent intervals a single cell is used in order to attain a higher

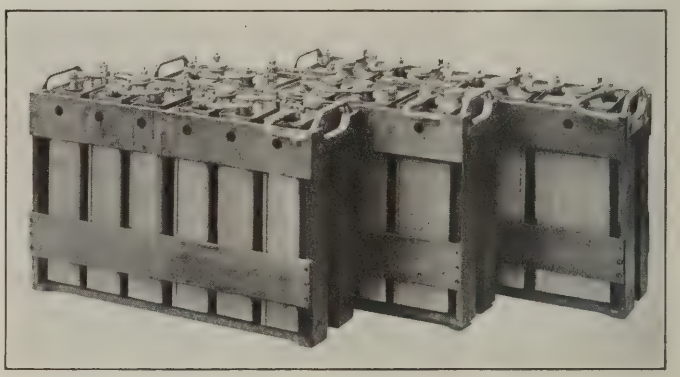


Fig. 3. Mounting of Cells in Wood Trays.

degree of accuracy. In the latter case the test is always repeated on at least one other cell. Of course no single cycle of charge and discharge is relied upon as being true, but the cycle is always repeated several times, or at least until the result becomes constant. In the curves to follow, characteristic single results only are usually plotted, to avoid confusion.

Innumerable repetitious of tests have shown that the cells as commercially manufactured have surpris-

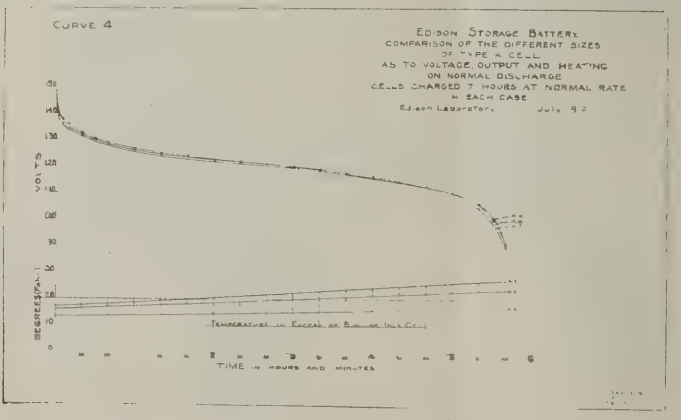



Fig. 4. Voltage Output and Heating Curves.

ingly uniform capacity; and that under any similar conditions, no matter how abnormal, different cells will give practically identical results. The same characteristic of constancy of behavior applies also to the different sizes of cell, and at comparative rates they have similar characteristics, except for inconsequential variations in heating due to differences of radiating surface. This is shown in the curves of Figure 4.

For all practical purposes, therefore, it is fairly safe to assume that what is true of any single cell will hold good for a battery of any number of cells if subjected to the same conditions; and furthermore that

*A paper presented before the Convention of the Associated Edison Illuminating Companies.

a result or curve taken from one size of cell will apply to other sizes equally well if the rate and output figures be made proportional.

### Test Electrodes.

In work with the Edison battery the necessity of some reliable and convenient method of analyzing voltage curves, to determine which electrode was limiting the capacity or causing changes of voltage, was early appreciated. The only scheme which had then been tried was the use of the metal container of the cell as a third electrode in the same manner that cadmium is used in lead cell tests. This was most convenient, but readings so taken were inconstant and not at all reliable on account of polarization which

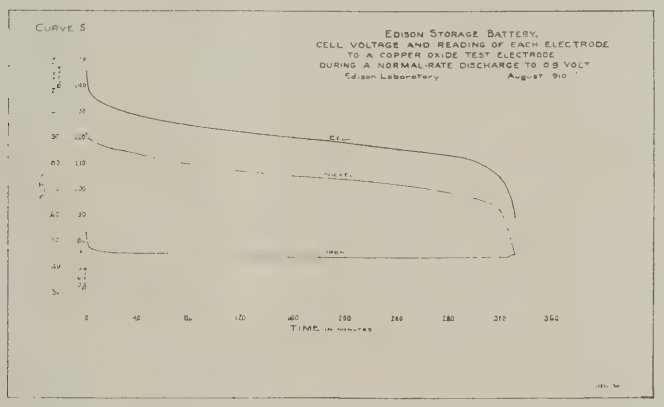

CURVE 5
EDISON STORAGE BATTERY.
CELL VOLTAGE AND READING OF EACH ELECTRODE
TO A COPPER OXIDE TEST ELECTRODE
DURING A NORMAL-RATE DISCHARGE TO 0.8 VOLT
Edison Laboratory
August 910
TIME in minutes

Fig. 5. Cell Voltage During Normal Discharge.

would be set up at the surface of the nickel-plated steel, even by the infinitesimal current taken by a high-resistance voltmeter. The author has devised several successful ways of attaining this end. One of these is theoretically applicable to any kind of primary or secondary battery, and practically also where suitable means exist.

The first device tried was that of a duplicate charged cell standing idle alongside the cell under test and having electrolytic connection with it through an inverted U-tube. Voltage readings would be taken from the positive of the cell under test to the negative of the auxiliary cell, and from the negative of the working cell to the positive of the auxiliary cell. The voltage of an idle charged cell remains practically constant over long periods of time, so variations in the readings thus taken must be caused entirely by the working electrodes, and the resultant curves would show the independent behavior of these. This method proved reliable but was inconvenient; and in the case of batteries in actual service could hardly be employed at all. The best scheme devised—one which has been used many years at the Edison Laboratory and has been successfully applied to various kinds of battery, including the lead storage battery—may be described in general terms as follows: The use as a third electrode of a partially reduced oxide which will undergo electrolytic oxidation or reduction in the given electrolyte without polarization. That the oxide should also be insoluble in the electrolyte is of course highly desirable, as its use cannot then contaminate the cell in any way. The oxide must be mounted in a suitable conductive support, and the electrode is preferably encased in perforated hard rubber so that it may be rested on the plate tops with impunity. For the common electrolytes substances fulfilling the above requirements are numerous, but those which the author has found best adapted to use are: lead peroxide for sulphuric acid batteries, and either cupric oxide or the high nickel oxide of a charged Edison positive for all alkaline batteries.

A copper-oxide test electrode can be prepared very easily from a plate of agglomerated cupric oxide such as is sold for use in the Lalande primary battery. A small block cut from a new plate of this kind is bound with fine copper wire and suitably insulated. It is then made cathode, using a passive anode, in a jar of the alkaline electrolyte—a medium current being passed for an hour or so, or until about one-fifth of the block has been reduced to metallic copper. After this treatment the electrode should be allowed to stand in electrolyte for a few days to "season"—that is, to become stable in voltage. The electrode is then ready for use and will remain in working condition almost indefinitely, provided it be kept in dilute electrolyte when not in use. If exposed long to the air the reduced layer of metallic copper will re-oxidize. Cupric oxide is very slightly soluble in strong alkaline solutions; but in the case of the Edison battery it has been found to have no deleterious effect, even when present in large amount, and can be used with perfect safety.

Test electrodes of nickel peroxide and of lead peroxide have been found to give excellent results in tests of the Edison and the lead battery, respectively, and have the advantage of being indigenous to those batteries so that no foreign substance is introduced.

Figure 5 shows a normal rate discharge of an Edison cell with independent curves of the electrodes taken by means of a copper-oxide test electrode.

### Normal Ratings.

The fixing of the normal charge and discharge rates and normal length of charge of the Edison battery is mostly arbitrary. The current rates given as "normal" in the table, Figure 2, were determined by a careful consideration of the factors of $I^2R$ loss in cell and

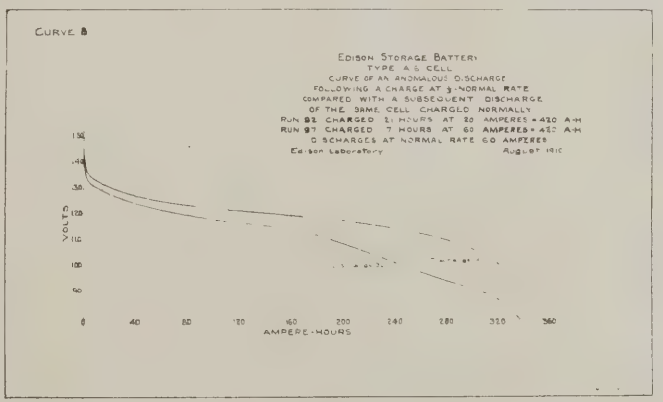

CURVE 8
EDISON STORAGE BATTERY
TYPE A 5 CELL
CURVE OF AN ANOMALOUS DISCHARGE
FOLLOWING A CHARGE AT 3 NORMAL RATE
COMPARED WITH A SUBSEQUENT DISCHARGE
OF THE SAME CELL CHARGED NORMALLY
RUN 82 CHARGED 21 HOURS AT 20 AMPERES = 420 A-H
RUN 87 CHARGED 7 HOURS AT 60 AMPERES = 420 A-H
D SCHARGES AT NORMAL RATE 60 AMPERES
Edison Laboratory
August 1910
VOLTS
AMPERE-HOURS

Fig. 6. Anomalous Discharge on Varying Charges.

the resultant heating, of time rates of charge and discharge, and of output; and were presumed to strike the best balance between the governing factors to suit the conditions of vehicle practice. Seven hours is taken as the normal length of a charge at normal rate simply because at this point the output and efficiency were judged to be in the best relation for average practice. These ratings are not obligatory, but the length of charge may be varied between zero and infinity as desired, and should be varied according to the output required in any particular service. The rates of charge and discharge are optional also when just two points are kept in mind. The first is that very low charge rates will not completely reduce—that is charge—the iron element, and the resultant discharge will be anomalous as to voltage (See Figure 6.

(*Concluded in the February Issue.*)

# General News and Personal Mention

### U. S. BULLETIN NO. 207.

The United States Light and Heating Company has recently issued Bulletin No. 207, dealing with the Bliss system of electric car lighting. The Bulletin defines the six essential parts of an axle equipment as follows: (1) The generator, belted to the car axle. (2) The suspension for holding the generator. (3) The Storage Battery. (4) The Panel or Controller Board. (5) The Lamp Regulator. (6) The Regulator Relay. A detailed description of these parts follows. The Bulletin is profusely illustrated with photographs of the equipment.

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Dossert & Company, New York, N. Y., have just issued an eight-page folder which illustrates and describes a number of Dossert specialties. Especial attention is given to the new type of anchor connector for use with strain insulators, and to a new insulated cover for cable taps.

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The National Metal Molding Company of Pittsburg, Pa., has just issued a catalogue of their indoor wiring accessories. The principal products are "National Metal Molding," "Sherarduct" and "Flexduct," together with various accessories used with them.

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### CHICAGO ELECTRICAL SHOW.

The Chicago Electrical Show will be held at the Coliseum January 7 to 21, 1911. According to the enthusiastic press agent it will be the largest affair of the kind ever handled in Chicago. Every phase of the electrical industry will be represented by exhibits, and all the large companies will be prepared to demonstrate their latest improvements. Although more popular in character than the exhibits presented at the conventions of the technical and professional societies, the show will neverthless contain much that will be of interest to all electrical engineers.

The United States government will show a very large and complete exhibit of all the manifold ways in which electricity is made to serve the War, Navy, Post Office, Interior and Treasury Departments. All the space in the Coliseum Annex will be devoted to this exhibit.

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The New York Insulated Wire Company has been mailing out blotters advertising Grimshaw white-core insulated wire and Grimshaw insulating tape.

---

The Electrical Engineers Equipment Company, Chicago, Illinois, is preparing to move into a new factory. Power House and Central Station specialties of all kinds are handled by this company.

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The Macbeth Evans Glass Company, of Pittsburgh, has recently sent out a booklet of photographs of installations of Alba glassware for street lighting. The mechanical work on the booklet is especially fine. All types of arcs and incandescents are shown.

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The National X-Ray Reflector Company has secured offices and show rooms on the ground floor of the new Brooks Building at the corner of Jackson Boulevard and Franklin Street, Chicago. This fine new location is admirably adapted to demonstration of the "Eye Comfort" system of indirect illumination.

### ADAMS-BAGNALL CO. BUYS JANDUS BUSINESS.

The Adams-Bagnall Company of Cleveland, Ohio, has purchased the business of the Jandus Electric Company of the same city. The manufacture of "Jandus" products will be continued under the trade name "Jandus," which has become very widely and favorably known, particularly in the electric fan field.

The Adams-Bagnall Company has associated with it the former management, of both the commercial and engineering departments, of the Jandus Electric Company. B. W. Stowe will hold the position of Engineer of the Fan Department. C. L. Eschleman is Sales Manager. The reason given for the change is the increased capital made necessary by the rapid growth of the Jandus Company's business, particularly in the railway field.

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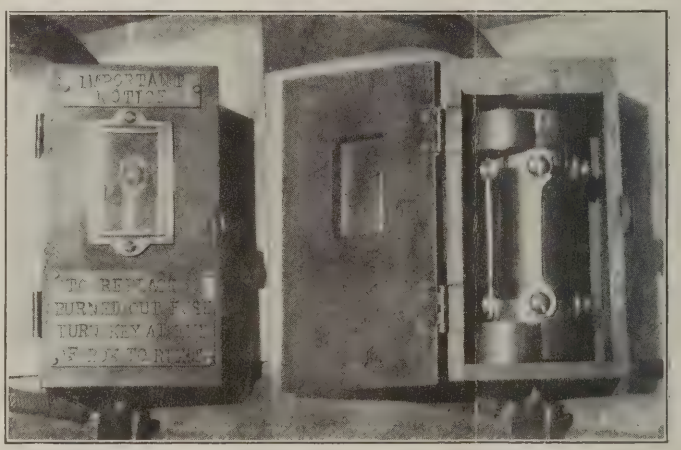
### SNAP SWITCH MULTIPLE FUSE.

Axle lighting trouble due to blown fuses has given rise to a need for some method of easily renewing them. To meet this need Mr. N. E. Lemmon, electrical engineer for the Pullman Company has designed the Snap Switch Multiple Fuse shown herewith.

This device consists of a cylinder of insulating material on the ends of which are mounted brass rings.



Snap Switch Multiple Fuse.

The upper ring is divided into four segments insulated from each other, and each connected to the lower ring by a fuse of the desired capacity. The contacts on the rings are made by brushes of sheet copper. The upper contact can be made on only one segment at any time. The cylinder is caused to revolve on its axis by means of a snap switch which turns it through a quarter-revolution.

When a fuse blows it is necessary simply to turn the snap switch to bring another into place. The device is mounted in a box with a hinged front door in which is a glass window through which the condition of the fuse can be seen at a glance. These fuses are being installed on all axle-lighted Pullman cars.

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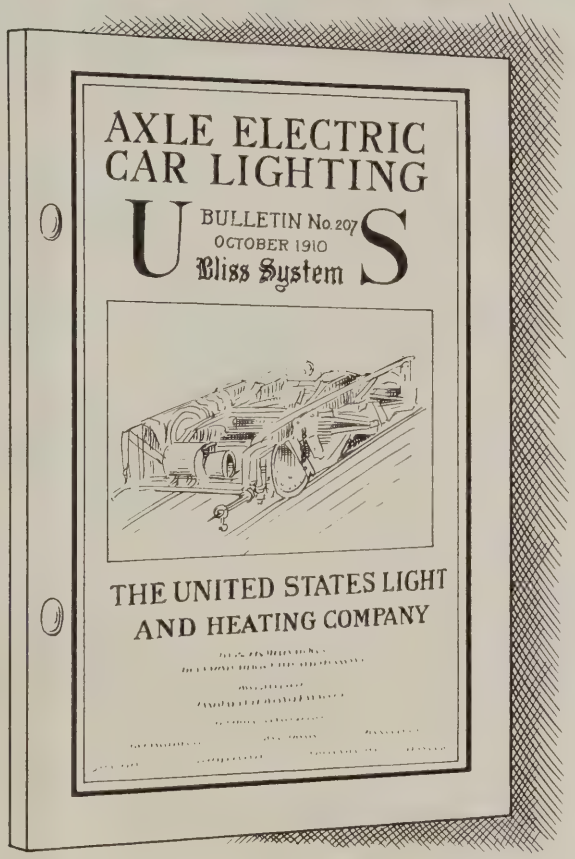
The American Electric Fuse Company, of Muskegon, Mich., has opened a Chicago office on the ninth floor of the Vogue Building, at 200 Fifth Avenue. A complete sample line of "Blue Ribbon" telephone protectors, "Allen-Bradley" motor starters, controllers, and battery-charging rheostats, and "American" magnet wire and ignition apparatus will be carried at this office, which is in charge of Fred D. Bonde.

# JUST OUT!




## BULLETIN 207

Descriptive of **The Bliss System** of Electric Car Lighting. This System has met the conditions imposed by modern railroading with such eminent success that it has become the Standard with many Railroads and Car Builders. **Perfect Regulation, Lowest Operating Cost,** and **Absolute Reliability** are assured to the Purchaser.

*Write to our Railroad Department for Bulletin 207.*

**The United States Light and Heating Co.**

**General Office: 30 Church St., New York**

"Bliss System of Electric Car Lighting." "National" Batteries. "Moskowitz System of Electric Car Lighting."

NEW YORK BUFFALO CHICAGO CLEVELAND St. LOUIS BOSTON SAN FRANCISCO

# Recent Patents

## OF INTEREST TO THE RAILWAY ELECTRICAL ENGINEER

### 976,878. ELECTRICAL SYSTEM OF DISTRIBUTION.

Albert S. Hubbard, Belleville, N. J., assignor to Gould Storage Battery Company. Filed June 19, 1908. A direct-current distributing system contains a storage battery and a booster therefor. The exciter for this booster has two field circuits, one in series with the main line and the other connected to the secondary of a series transformer in the same line so that it is subject to the effect of sudden load variations only.

### 976,925. AUTOMATIC PRESSURE-CONTROLLING DEVICE FOR BRAKE MECHANISMS.

Harold Rowntree, Chicago, Ill., assignor to National Pneumatic Company. Filed Jan. 19, 1910. An air brake for cars has electrical devices for operating the air valves, and means controlled by the speed of the car for governing the circuits of these devices.

### 977,443. STORAGE-BATTERY PLATE.

Bruce Ford, Philadelphia, Pa. Filed April 14, 1910. A lead battery plate consisting of a large number of horizontal leaves with opening clear through the plate, the leaves being held together by vertical ribs.

### 977,554. ELECTRICAL EQUALIZER SYSTEM.

Otto S. Schairer, Pittsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed September 3, 1907. Renewed May 20, 1910. An alternating-current distributing system contains a pair of equalizing machines adapted to run either as generator or motor and supplied from different phases of the circuit.

### 977,571. SYSTEM OF ELECTRIC-MOTOR CONTROL.

Wilbur H. Thompson, Wilkinsburg, Pa., assignor to Westinghouse Electric & Manufacturing Company. Filed January 5, 1907. A single controlling means serves to interrupt the supply of energy to the hoisting motor and to temporarily reverse the motor when either of two limits is reached.

### 977,653. ELECTRIC COLLECTOR FOR TURNTABLES.

Laban E. Jones, Anaconda, Mont. Filed August 15, 1910. A method of supplying current to a turntable from an overhead supply.

### 977,940 AND 977,941. SHADE OR REFLECTOR ATTACHMENT.

Henry D'Olier, Jr., Philadelphia, Pa., assignor to Holophane Glass Company, New York, N. Y. Filed December 8, 1909. The reflector is attached to the socket by supporting fingers.

### 978,163. ELECTRIC-LIGHTING FIXTURE.

Lemuel R. Hopton, Plainfield, N. J., assignor to Enos Company, New York, N. Y. Filed March 1, 1910. An electric-candle fixture consists of a candle cup, a retainer yoke within the same, a candle tube and a switch within the yoke.

### 978,173. ELECTRIC MOTOR-CONTROLLING APPARATUS.

Harry Ward Leonard, Bronxville, N. Y. Filed January 23, 1905. Renewed February 20, 1907. A starter and speed controller is provided with overload and no-load release coils and a device to prevent starting the motor except with the contact arm of the field rheostat on the no-resistance point, thus preventing a weak starting field.

# Association Directory.

## ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....323 Kinzie St., Chicago.**

The next convention of the Association will be held in Washington, D. C., in the first week of June, 1911. The Annual Convention will be held in Chicago in the second week of November, 1911.

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General Electrician, Pennsylvania Railroad, Altoona, Pa.

**First Vice-President.**

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Asst. Elec. Engineer, C. & N. W. Railroad, Chicago, Ill.

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H. C. Meloy, Chief Electrician, Lake Shore & Michigan Southern Ry., Cleveland, O.
F. E. Hutchinson, Chief Elect., C. R. & P. R. R., Chicago, Ill.
C. J. Causland, Chief Elec., Penna. R. R., Chicago, Ill.

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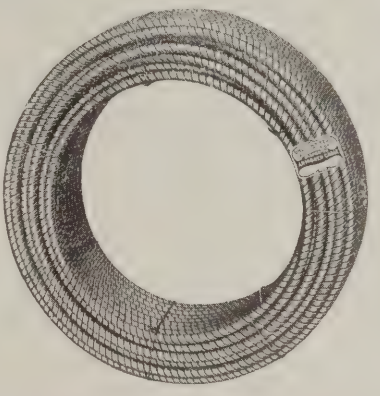

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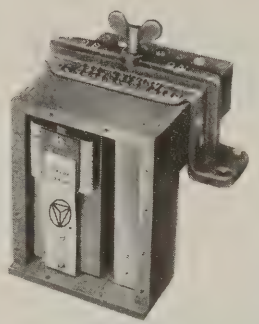

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BEARING BRACKETS can be turned around for wall or ceiling operation without disturbing the electrical connections.

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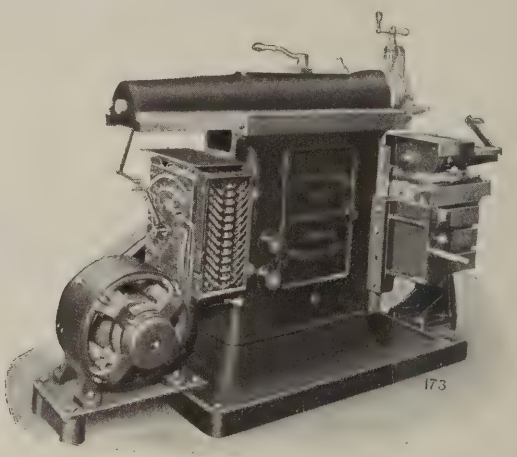

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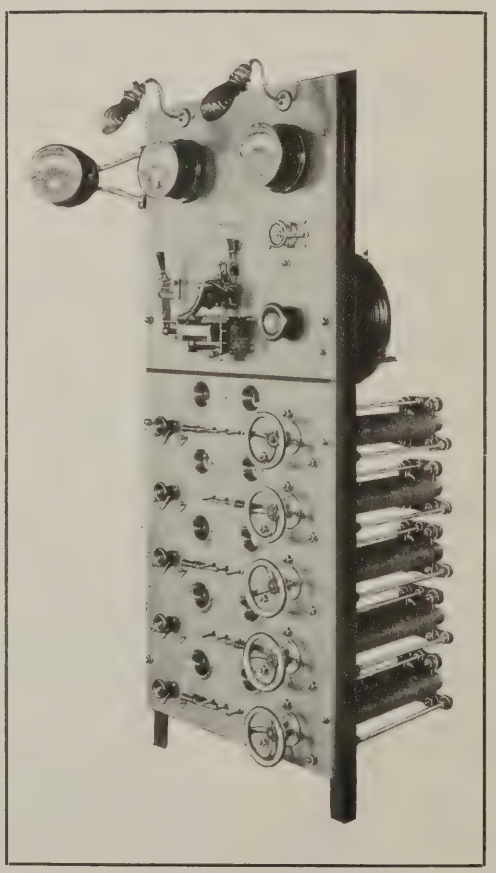

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# For railway train lighting—either straight storage or axle system—

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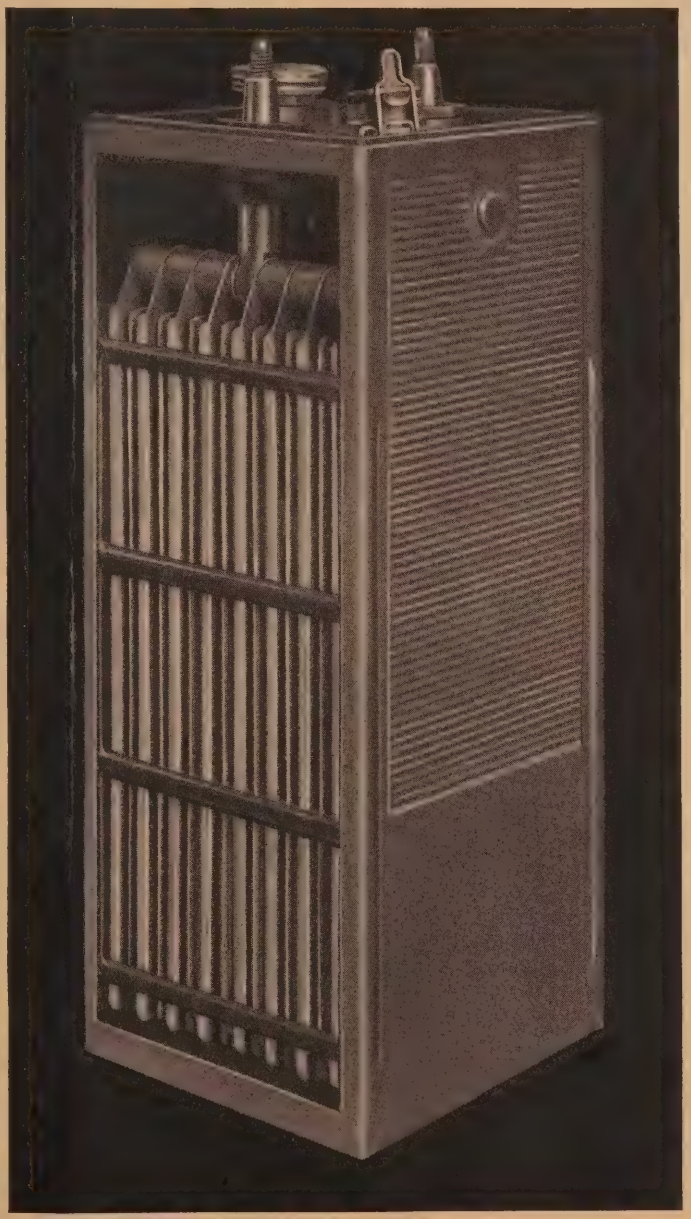

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We have precise figures on this. In the face of this statement, can you afford *not* to investigate these figures? Make us prove this claim. Write us today.

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**60 volt equipment weighs two tons less than lead battery.**

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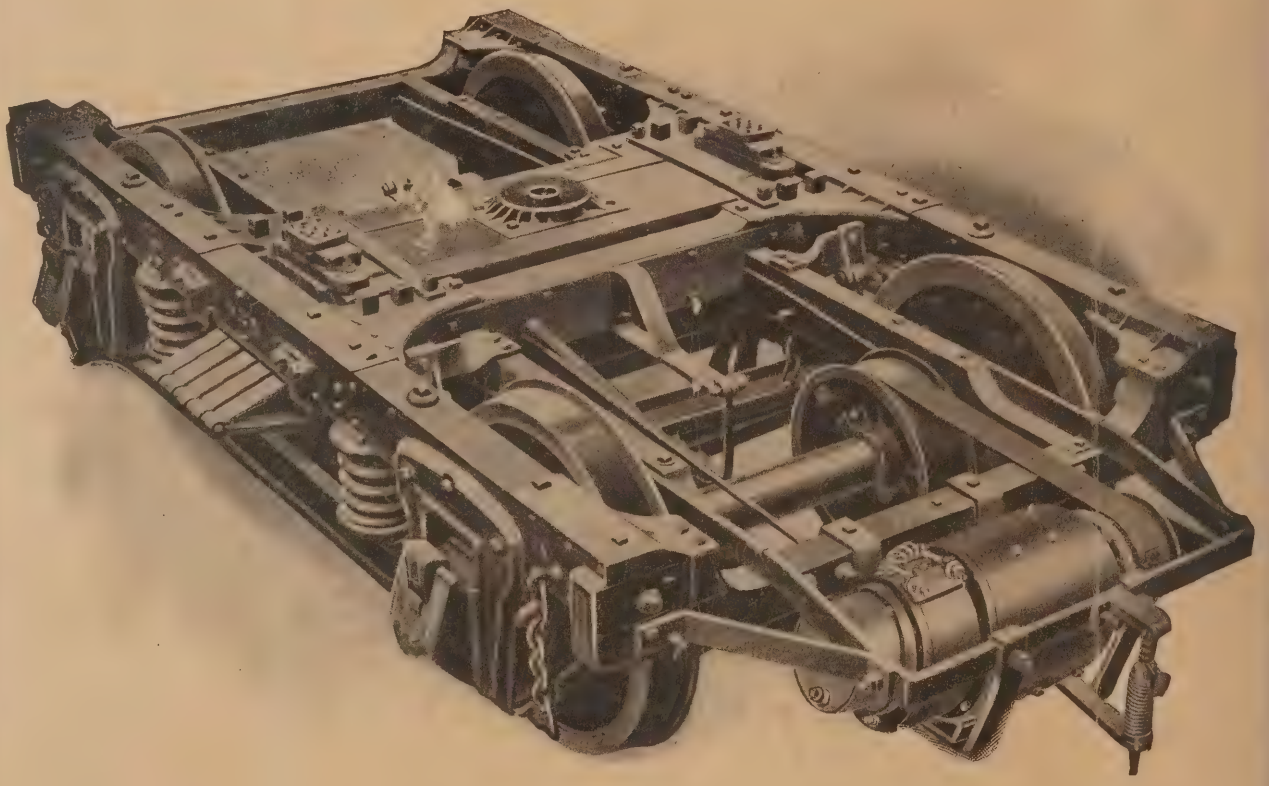
**EVERY EQUIPMENT GUARANTEED.**

**Regulating device for both Dynamo and Lamps concentrated in one machine**



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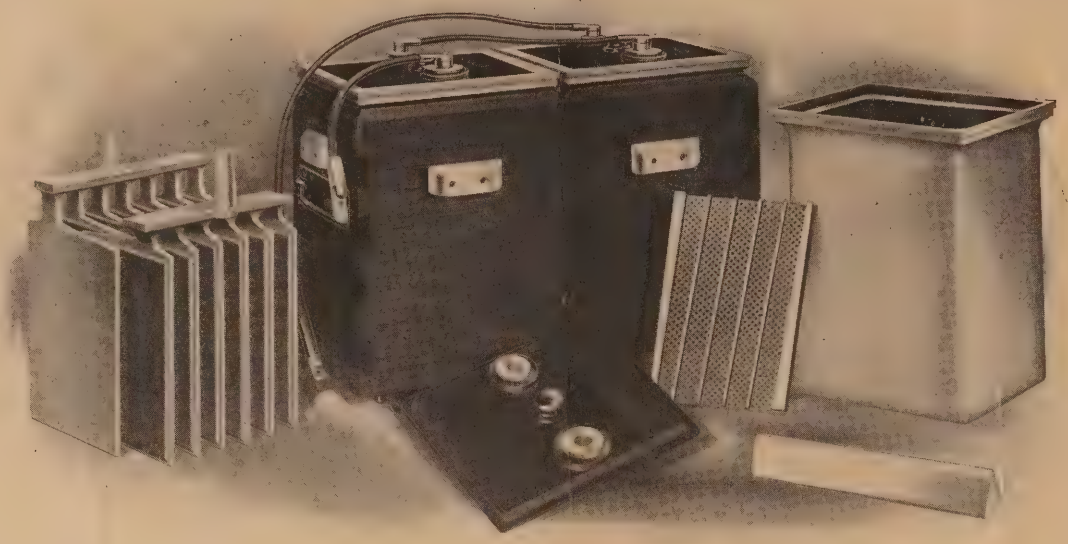

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**The Heavy Core Plate which prevents Buckling.**
**Absolute Uniformity in the Active Portion of Plate.**
**The Only Factory that Specializes in Train Lighting.**
**Moderate First Cost. : : Lowest Maintenance.**

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**They give soft, white light without glare; diffuse perfectly with least loss of illumination. Smooth on both sides; easy to clean. As artistic as they are efficient.**

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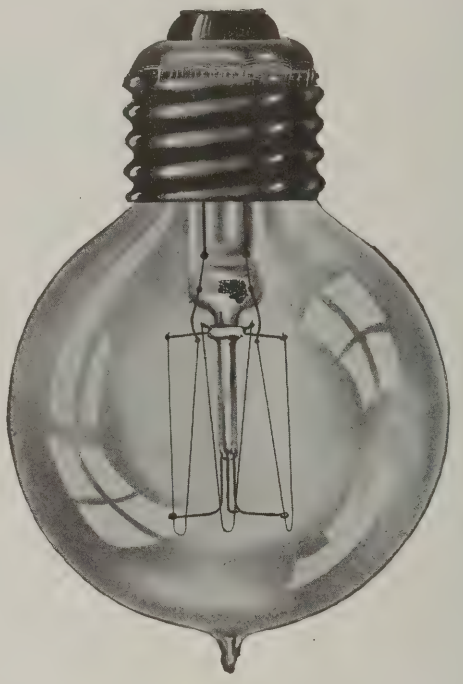
# BUCKEYE

## TRAIN LIGHTING LAMP



embodies all the highest qualities to be found in any lamp. It is the result of a most careful study into the train lighting proposition and has been carefully designed to meet the special requirements of this service.

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# Ampere Hour Meters for Storage Battery

## equipment will increase the life of the battery and provide an absolute check on the entire equipment

When applied to the operation of straight storage equipment the saving in current effected by the meter over that required when charging by the gravity method, will pay for the meter in three months.

In connection with Head End or Axle Lighting Equipment, the *Duplex Train Meter* provides an absolute check on the operation of the equipment, ensuring proper charging of the storage battery, and more reliable operation of the whole equipment. It will show you exactly how much the storage battery is being overcharged or undercharged.

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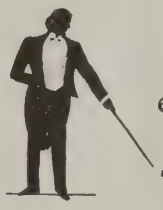
**SANGAMO ELECTRIC COMPANY**

**Springfield, Illinois**



What you want from an electric lighting equipment is

# Light

You want light *in sufficient quantity* and *of proper quality.*

You want this light *when you want it* and *where you want it.*

You want this light supplied at a *minimum cost* of labor, material and depreciation.

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We are furnishing a *complete electric system* from the generator to the lamps.

We furnish a generator of *ample capacity for all the light you want.*

It is *ready when you want it.*

Our fixtures distribute the *light where you want it.*

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The careful consideration of each and every component part and operation in its relation to the *efficiency of the system as a whole* is the foundation principle in the design and manufacture of our electric equipment.

This system is known as our *B. C. S.*

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*The generator* has the *latest improved suspension,* is *positively dust-proof, easily accessible* and has *ample capacity for all service.* The oiling device is positive, providing *ample lubrication,* the *pole changer is automatic* and simple and the armature is designed according to latest improved practice with form wound coils.

*Our dynamo regulator* is designed and *built to insure proper battery charge* by perfect control of the generator output. This control is accomplished by a carbon pile resistance in series with the dynamo field, and is varied by the action of a current and a voltage solenoid to *meet the varying conditions of speed and battery charge.* The constant normal rate of battery charge is lowered when approaching full charge and continues until the battery is *fully charged.*

The generator *cannot be overloaded* as the output does not exceed that for which the regulator is set; but the *maximum output is always available.*

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*The lamp regulator* keeps the *voltage constant on any number of lamps,* from one to the full number in your equipment, by a variable carbon resistance in series with the lamps.

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All necessary connections and resistance units are located on the *front of the regulator boards and easily accessible.*

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**For All Forms of Railway Service**

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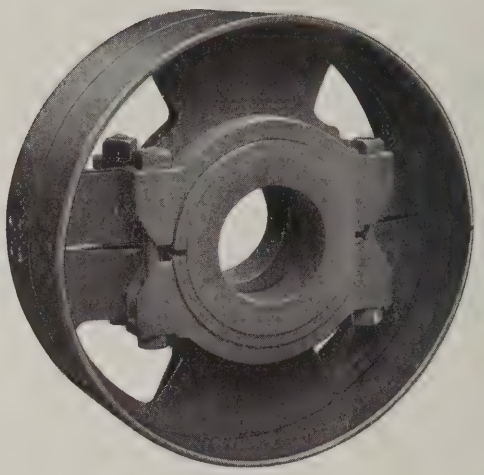

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## For Railway Car Electric Lighting

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It is a parting pulley:—light, strong, easily put on or taken off, indestructible, accident proof.

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Of all the various forms of pure Plante type of battery plate construction, the "Tudor" Positive Plate, illustrated herewith, has the unique distinction of possessing the greatest mechanical strength.

The "Tudor" positive plate has the following special features:

1. An exact proportioning of the ribs.
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3. Reinforcing features made possible by its type of construction.
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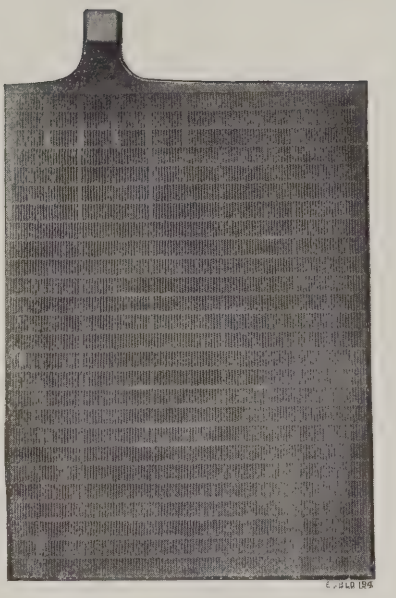
The "Tudor" plate structure is such as to give strength, to minimize growth and buckling, and to decrease sediment. These features are an assurance of long life.



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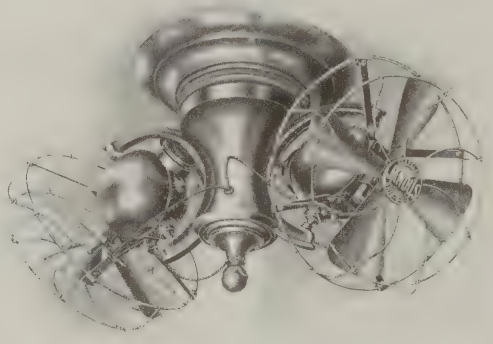

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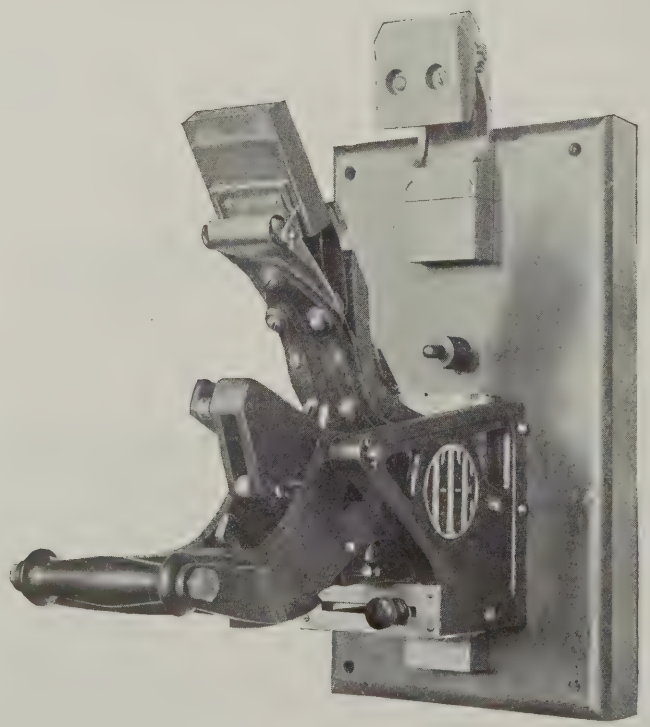

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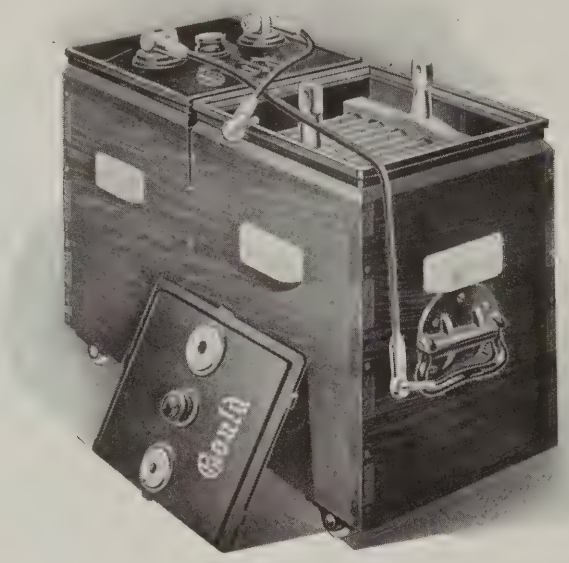


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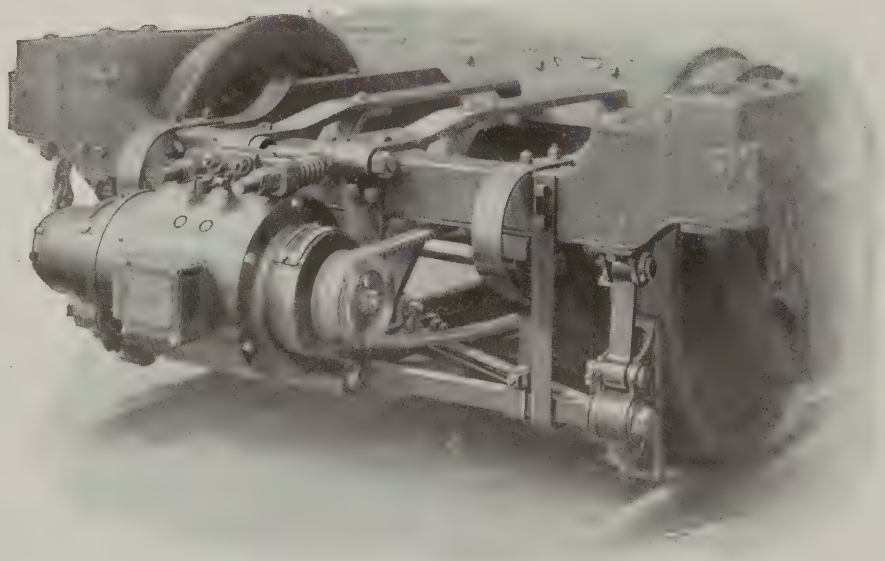

**GOULD COUPLER COMPANY,** 341-347 FIFTH AVE., NEW YORK
THE ROOKERY - CHICAGO

# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

WRAY PUBLISHING CO.

EDWARD WRAY, President. J. G. WRAY, Sec. & Treas.

RALPH BIRCHARD, Manager.

92 LA SALLE ST. CHICAGO

Telephone Main 2457.

Editors ..... Edward Wray, C. L. de Muralt, Geo. W. Cravens, Ralph Birchard

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

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TERMS OF SUBSCRIPTION

United States, Canada and Mexico . . . Per Year, $1.00


**OUR OBJECT.**

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


EDITORIALS—

The Passing of the Telegraph ..... 189
Chicago's Attitude Toward Electrification ..... 189
The Railway Electrical Engineer Dope Sheet ..... 189
Association News ..... 190
Car Lighting Club ..... 190
Storage Battery Trucks for Freight Handling ..... 191

ELECTRIC TRACTION SECTION—

Terminal Electrification ..... 192
The Turning of the Tide ..... 195
Power Transmission by High Tension Direct Currents ..... 197
Electric Work in the Hoosac Tunnel ..... 197

SHOP SECTION—

Some Features of Synchronous Motor Operation ..... 198
The New Haven Shops at Readville, Mass. ..... 199
Some Points Relating to Railway Shop Power Plants. 200
The 1910 Edison Storage Battery ..... 201
General News and Personal Mention ..... 204
Association Directory ..... 14


### The Passing of the Telegraph.

THE electric telegraph was a marvelous invention. It made possible the operation of steam railroad trains at high speeds. Its service to humanity has been of incalculable value. A thousand traditions cling about it. Traditions tragic, comic; of bravery, of sheer nerve. The Civil War might have resulted far differently had the telegraph not been invented at that time. It has filled a great need. But it has seen its day. Probably within ten years not a single large railway in the country will use the telegraph for train dispatching.

The telephone is its successor. Within the last two years the tinkle of the telephone bell has crowded out the click of the telegraph on thousands of miles of railway.

The advantages of the telephone are obvious. The chiefest of them is that while only the few can use the telegraph, any one can use the telephone. The objection first raised to it was that it might be less accurate. This is a very important objection, for train dispatching is something which demands absolute accuracy and perfect understanding. But experience has proved that train dispatchers can say what they mean as well with their mouths as with their fingers, and that operators can understand words as well as clicks. With portable telephone equipment the conductor of any train at any point can get instantly in touch with the train dispatcher. There are instances in which this may save hours of time and much confusion.

### Chicago's Attitude Toward Electrification.

THE attitude of Chicago toward the electrification of the railways within its borders is, in many ways, exemplary. Instead of arbitrarily demanding that electrification be accomplished at once, the Chicago Association of Commerce has taken the time and pains to find out whether such a demand is reasonable and just. During the year 1910 a committee composed of engineers examined the engineering feasibility of the proposition. This committee has recently reported that, from an engineering standpoint, it is entirely feasible.

Accepting this report, the Association has now appointed a committee to investigate the financial side of the question. A similar committee has been appointed from the city council. The two will meet in joint sessions from time to time. At the end of the year they should be able to present a report with great authority. This report will no doubt furnish the basis for whatever steps the council may take.

There is no doubt but that, among the public at large, there is a widespread sentiment in favor of electrification. This sentiment has been fostered by the newspapers. Undoubtedly, it is justified. Electrification is extremely desirable. Whether it is financially feasible is a question for the committees to decide.

In the interest of the cause which they have espoused, the newspapers have tried to make it appear that all railway men are opposed to electrification. Such is far from the truth. There are very few railway men who would not welcome the chance to electrify. With them it is merely a question of expense. If it is possible to make electrically operated roads pay a reasonable return upon the investment, electrification will come very soon.

We believe that it is possible. We believe that electrification is coming very soon. We do not believe in arbitrary legislation which forces upon the railways an expense that is unjustifiable. This seems, also, to be the attitude of the Chicago Association of Commerce, and we believe that the attitude of this body may fairly be said to be that of Chicago.

### The Railway Electrical Engineer Dope Sheet.

COMMENCING in the March number we will run each month a Dope Sheet. Dope Sheet is a rather unconventional term for a page of invaluable information condensed into the smallest convenient space. It is probable that our old friend N. Webster would not approve of the word "dope." Nevertheless we believe that usage has sanctioned the word and made it good English, if not extremely elegant form.

## ASSOCIATION NEWS.

**This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.**

**It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.**

### THE 1910 PROCEEDINGS.

The work of getting out the 1910 Proceedings of the Association is nearly completed. It is expected that these will be ready for delivery by February 5th. The book will not be quite as large as last year. This is due to a somewhat more severe editing. A great deal of superfluous conversation has been cut out, leaving only the really important parts of the discussion. The membership list has been brought strictly up to date, all those in arrears for 1910 dues having been dropped. No copies will be sent to members who have not yet paid their dues for the current year.

The book will be enlivened by numerous illustrations. A picture of those in attendance at the Buffalo convention is included, as well as one of the annual banquet given to the members by the Association of Railway Electrical Supply Manufacturers. Sufficient advertising is carried in the book to pay for the cost of publication.

## CAR LIGHTING CLUB.

The January meeting of the Car Lighting Club was held on the evening of Wednesday, January 4th, at the Chicago Press Club. The attendance was not as large as at some of the previous meetings, due probably to the inclement weather. Those who came, however, were well repaid by the excellent paper on "The Selection and Care of Alternating Current Motors" which was presented by W. S. Taussig.

Mr. Taussig said that the care of alternating current motors differed in no way from the care of any other motors, and that the maintenance charges on an alternating current equipment should not be any higher than those for direct current.

The alternating current motor differs from the direct current motor in that it runs at practically a constant speed under all conditions. Therefore, on machines requiring frequent changes of speed, the A. C. motor is not applicable to the best advantage. Mr. Taussig contended that there are few such machines in the railway repair shop. Railway shops are not manufacturing establishments, and there is not at present any standard practice regarding them, either in machine tool drive or in power plant design.

Although there are certain machines, such as planers, and car-wheel lathes, which require variations in speed, these variations can be secured through gearing more economically and almost as quickly as with direct current motors where the speed is varied by electrical control. Machine tool manufacturers are now providing for a wide range of speed through gearing. The pinions on these gears are so constructed that they mesh easily when the machine is running. A change of speed can therefore be secured without stopping the motor. The use of cone pulleys to accomplish speed changes is rapidly being discontinued.

A disadvantage of the alternating current motor in crane service is that it cannot hoist a light load any faster than a heavy one. In a shop where there are perhaps two or three locomotives to be hoisted in a day, and a hundred pairs of wheels, this disadvantage is serious. It has been overcome by providing two sets of hoisting motors on the crane, one high speed, for lifting light loads, and the other slow speed, for lifting heavy ones. This is usually cheaper than installing motor-generator sets, which, with the variable crane load, would usually operate at rather low power-factor.

The distance of the power plant from the shop is a large factor in the selection of a system. The further the two are separated, the greater becomes the advantage of alternating current due to the economies possible in the transmission line.

A large number of lantern slides showing the application of motors to various machine tools were used by Mr. Taussig to illustrate his remarks.

### Discussion.

Mr. Farrelly (C. & N. W.) stated that although originally opposed to it, he had recently been converted to alternating current, not only for shop use, but also for coal hoists, pumps, and a variety of other uses.

Fig. 1.—Storage Battery Baggage Truck for Freight-Handling.

Mr. Gilman (C. M. & St. P.) said that it required the services of three inspectors to keep the motors in his Milwaukee repair shop in working order, which was, to him, quite an argument in favor of alternating current.

Mr. Murray (C. & A.) was not so much impressed with the arguments of the speaker. He said that he considered direct current best adapted for certain machines. He took issue with others on the question of rawhide versus steel pinions, citing an instance where by the use of rawhide pinions he had been able to secure excellent service from a motor which had hitherto given a great deal of trouble.

The next meeting of the Club will be held at the Chicago Press Club on the evening of February 1st. The subject for the evening is Car Ventilation.

# Storage Battery Trucks for Freight Handling

A very unique application of electric power has recently been made in the East. The New York Dock Co., the D., L. & W. R. R. Co. and others have several electric trucks of a peculiar design in service for hauling freight about their docks, yards and warehouses. They run about over the inequalities, up and down inclines and around corners like big caterpillars.

These trucks have a rated capacity of two tons each, but can handle four tons if necessary, and take the place of an industrial railway with its fixed route and tracks. The trucks are of the three-point suspension type, although all four wheels are on the ground at all times, as the platform, which is double, hinges in the center directly over the main axle. The large pair of wheels in the center are the drivers, the smaller wheels near the ends being used as supports for the outer ends of the platforms. When running, these small wheels are used for steering and are connected so they operate simultaneously, as shown in Fig. 2.

The steering wheel and controller handle are removable, and a controller is mounted below the platform at each end so that the trucks can be operated in either direction. This allows the operator to run up into narrow passages and get out again by simply transferring his wheel and controller handle to the other end.

These trucks are equipped with Edison nickel-iron batteries, which the makers, the Lansden Co., of Newark, N. J., have used on all of their electric vehicles for several years in preference to the lead plate batteries. At a maximum speed of 4½ miles per hour, the trucks can be run 18 miles on one charge. A single General Electric automobile motor is used, and is mounted beneath the platform of one half of the truck, while the battery is swung below the other half. This leaves the platform entirely free and clear for freight.

The total weight of these trucks is 2,750 pounds, complete. The wheels are fitted with solid rubber tires. Double reduction through chains is used for driving, provision being made for both alinement and adjustment.

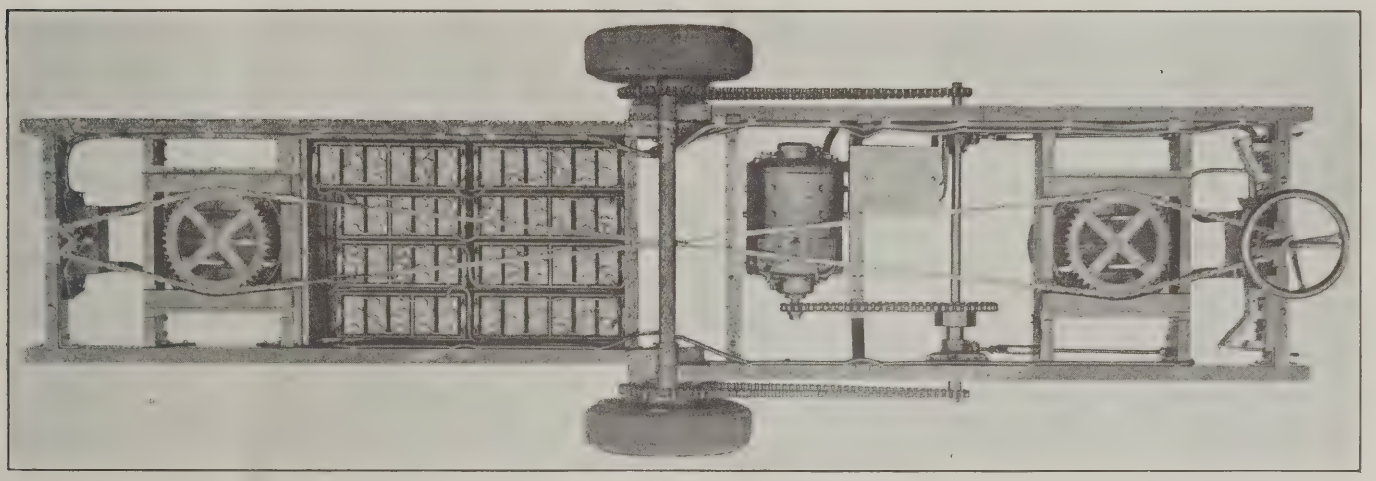


Fig. 2.—Truck from Above—Floor Removed.

As these trucks are suitable for use in shops and factories as well as for freight and passenger stations, warehouses, etc., some figures showing cost of operation are given in the accompanying table:

COST OF OPERATION AND MAINTENANCE.
Two-ton truck with current at 6 cents per kilowatt-hour.

| Miles per day. | Miles per year. | KW. hrs. per day. | Cost per year. Tires. | Batt. | Supp. | Rep. | Curr. | Total cost per year. | Cost per mile run. |
|---|---|---|---|---|---|---|---|---|---|
| 12 | 3,600 | 8 | $54.00 | $72.00 | $36.00 | $40.00 | $144.00 | $346.00 | $.096 |
| 18 | 5,400 | 12 | 81.00 | 108.00 | 54.00 | 50.00 | 216.00 | 511.00 | .095 |
| 24 | 7,200 | 16 | 108.00 | 144.00 | 72.00 | 60.00 | 288.00 | 672.00 | .093 |

Since the average load will probably be very close to one ton, it has been found that the cost is about 10 cents per ton-mile aside from labor. The cost of handling goods by electric trucks of the ordinary type, at the Pittsfield works of the General Electric Co., has averaged 38 cents per ton within the plant, so a small truck like the one described here should soon pay for itself out of its savings.

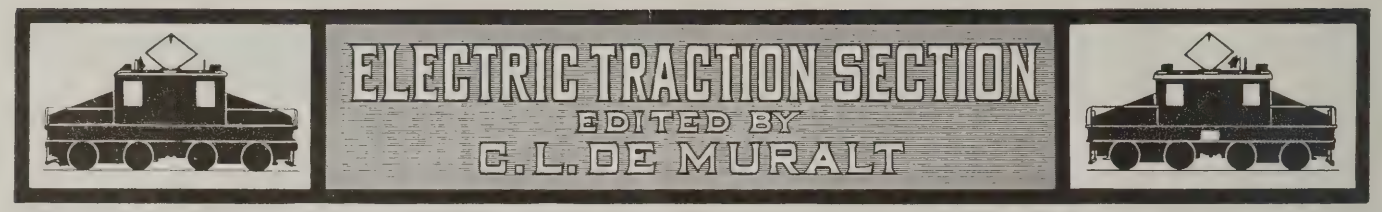
### J. R. SLOAN GETS PROMOTION.

J. R. Sloan, president of the Association of Railway Electrical Engineers, has been appointed engineer of electric car lighting on the Pennsylvania Railroad. This is a promotion from the office of general electrician, which he previously held.

E. E. Godard has been made assistant engineer of electric car lighting on the same railroad, and D. G. Thwaites and J. C. Snyder have been made train lighting inspectors.

### A. C. MOORE GOES TO NEW YORK.

Beginning with February first, Mr. A. C. Moore will be located in New York City where he will be in general charge of sales for the Safety Car Heating and Lighting Co., This is a promotion from the position of General Manager of the Northwestern District which he has held for some time past. J. C. Van Winkle will succeed Mr. Moore in that office. He has been Sales Engineer for the district.




# Terminal Electrifications

There is something radically wrong with the present way of treating the question of terminal electrifications.

Let us look this matter square in the face. There are naturally two sides to the question.

On the one hand we have the public, clamoring for immediate and wholesale electrification of all lines entering large cities. And the public is apparently perfectly willing to commit the rank injustice of forcing its viewpoint upon the railroad companies, by law if necessary.

On the other hand we have the railroad companies, evidently irritated by the attitude of the public, but apparently unable to grasp the full meaning of the situation. They seem to see at present nothing but the large additional expenditures required for the electric equipment.

The public appears to be perfectly oblivious to the fact that, if electrification is forced upon roads that cannot afford it—in other words, if electricity is installed in places where it is of the nature of a luxury rather than a necessity, it will be the public that in the long run will have to pay for the luxury.

The railroads, on their side, do not seem to realize that it is today both feasible and advantageous to use electricity on a great many lines, not alone for suburban passenger service, but, and perhaps even more so, for freight, especially in congested freight yards.

It won't do, of course, to simply replace the steam engine by an electric locomotive and maintain general steam railroad conditions on an electrified line. If this procedure were adopted, it is quite likely that the resulting deficit would be of the magnitude estimated by those who now object to electrification.

Neither will it do to transplant electric equipment developed for certain specific conditions, say for instance for the New York City terminal operations, to some other place where the conditions may be radically different.

Catalog engineering is bad under all circumstances, but it is absolutely out of place in connection with trunk line electrification matters.

Suppose, however, that the problem be turned over to an expert electric railway man.

Let him look at it on the basis of his experience of what can be done by taking full advantage of the peculiarities of electricity as motive power.

Suppose this man be given a relatively free hand to arrange traffic, or rather the handling of traffic, so as to reap the full benefit of the changed conditions. In that event there is no reason whatsoever for thinking that the outcome will be anything but satisfactory to all concerned.

Electric railroads of the interurban type have made good under the most trying conditions, of poor alignment, circuitous routes, low fares, etc.

Surely, electrified steam lines, with their splendid roadbed, private right of way, and other advantages, must be in a position to do even better under the same kind of management. The only disadvantage they now have lies in the fact that their private right of way affords a somewhat less flexible means of collecting and distributing passengers from house to store or office and vice versa. But this ought to be more than made up by the higher schedule speed and smoother running possible on private right of way, and by some other points in favor of the electrified steam railroad.

A good many railroad managers are in the habit of complaining that they are now losing money on their suburban passenger business. Sometimes they even point out, that, while traffic on other parts of the line is continually increasing, on the suburban portions it is stationary or worse.

They seem to forget that it is principally due to the competition of the electric street car lines that they are obliged to talk that way. Wherever they have braced up, squared around and met their competitors on their own grounds, things have invariably come their own way.

The American examples are too young to plainly show this. Let us take some of the European lines and the matter will be perfectly evident.

Take, for instance, the Lancashire and Yorkshire Railway in England. Eight or ten years ago this road was suffering heavily, due to the competition of the electric car lines. It was then decided to electrify. Last year, as a result of three years' actual operating experience, Mr. H. E. O'Brien, engineer of electric traction of the Lancashire and Yorkshire Railway, summed up the advantages of electric operation over steam as follows:

(1) More rapid and frequent train service can be given.

(2) Increase of 50 per cent in terminal facilities without capital expenditure.

(3) Cost of rolling stock reduced 20 per cent.

(4) Repairs to rolling stock decreased by from 10 per cent to 50 per cent.

(5) Running costs decreased by 30 per cent to 50 per cent.

And over and above all this stands out the fact that the Lancashire and Yorkshire Railway has not only regained all the traffic which it had previously lost to its competitors, but electrification has added, and is still adding, to the passenger traffic at the rate of 1,000,000 additional passengers carried each year.

The Mersey Railway shows almost identical conditions and results. In this case the data give the yearly increase in per cent. The gain in traffic is 78 per cent for six years, or an average of 13 per cent each year.

Now, suppose we look at a concrete American case and try to see where the trouble lies.

Let us take the case of the city of Boston, Massachusetts, where the question of electrification of the steam railroad terminals has been agitated for several years.

In February, 1910, a joint board made up of the Massachusetts Railroad Commission, the Boston

Transit Commission, the Metropolitan Park Commission, and the Harbor and Land Commission, reported to the Legislature on the commercial and transportation aspects of the improvement of the Boston Metropolitan District in accordance with the directions of the General Court in 1909.

It was reported that the suggested improvements in the railway service of this district were predicated on the substitution of electricity for steam.

It was recommended that the Legislature require all railroads in the district to report on the possibility of the change.

The Legislature made such a direction and named the Joint Board on Metropolitan Improvements, before mentioned, to receive the reports.

Reports were handed in by the Boston and Albany Railroad, and by the New York, New Haven and Hartford Railroad in its own behalf and in behalf of the Boston and Maine Railroad, of which it is the lessee.

Fig. 1.—Map of Boston and Surrounding Country, Showing Lines Under Consideration for Electrification.

Fig. 1 shows the approximate lay of the land and in the reports just mentioned the viewpoint of the railroads is expressed about as follows:

Mr. E. H. McHenry, as vice president of the New York, New Haven and Hartford Railroad Company, showed that there would be required an equivalent of 461 miles of single track electric equipment, the total cost of which would be $32,751,000, including generator stations, locomotives, etc., $13,862,750 for the New Haven and $18,889,192 for the Boston and Maine.

He would use the same type of construction as now employed between Woodlawn and Stamford on the New York division of his company, namely, an overhead contact line operated at 11,000 volts with single-phase alternating current.

His estimate is based on the assumption that only passenger tracks would be electrically equipped, no freight and switching service.

A normal generating capacity of 60,000 kilowatts is required.

Based on summer schedule of 1910 equipment must be provided for operating 14,630 daily train miles, or 17,286 including deadheading and helping.

Estimates cover the electrification of the service of the New Haven between Boston, Campello, Cohasset, South Braintree, Headville, Dedham, Mattapan and Needham Junction, and of the Boston and Maine between Boston, Swampscott, Wakefield Junction, Wilmington, Lexington, Wayland and Waltham.

It would be preferable not to restrict electrification to the Metropolitan District proper, as this means the needless establishment of some 13 intermediate transfer terminals, and better results could be obtained by using electricity as motive power for the full length of each run or engine district.

The operation of a mixed steam and electric service near New York has proved very unsatisfactory and no general substitution of electric for steam traction should be made unless the substitution be complete, including passenger and freight operation and yard switching.

The enlargement of the limits and the inclusion of freight service and yard switching would mean additions of considerable magnitude to above estimate.

It would seem most practicable to at first restrict the substitution of electricity for steam to a few of the more important routes, subsequently extending the system as rapidly as consistent with the financial conditions and the public needs.

Mr. A. H. Smith, as vice president and general manager of the Boston and Albany Railroad, stated that the total track length involved for his company was 128 miles, and the total cost of equipping same for electric service was estimated at $7,520,300.

He would use a direct-current third-rail system, similar to that now employed by the New York Central Railroad at its New York City terminal, but substituting 1,200 volts for the 600 volts used in New York.

The generating station would be of 22,500 kilowatt capacity.

His studies cover the four-track main line from a

junction with the South Station to South Framingham, the double-track Highland Branch of the Newton Circuit, and about 25 miles of yards and sidings. The Newton Lower Falls branch is now electrified.

South Framingham is outside the Metropolitan District proper. The extension adds about five miles of main line, but offers a better terminal for electric service.

Mr. McHenry is not prepared to estimate the allowance to be made for the replaced steam locomotives and passenger coaches. Mr. Smith estimates $1,107,000 to be the proper credit to allow for about 29 steam locomotives and 113 passenger coaches, which will be released upon electrification of his road.

This leaves the new investment required of the New Haven at $32,751,000 for equipping 461 miles of track, and that of the Boston and Albany at $6,413,300 for equipping 128 miles of track.

No wonder the two roads are not particularly enthusiastic about electrification.

Suppose, however, we look at these figures a little closer.

That of the New Haven is the larger and we will therefore take it first. It is made up as follows:

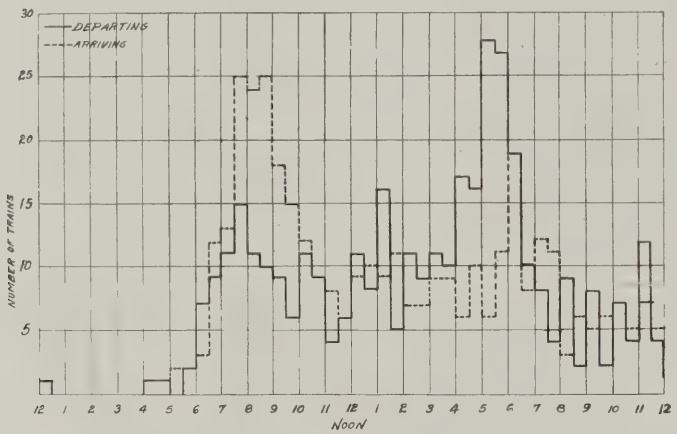



Fig. 2.—Diagram Showing Number of Trains Arriving and Departing Each Half-Hour from South Station, Boston. (June 5, 1910.)

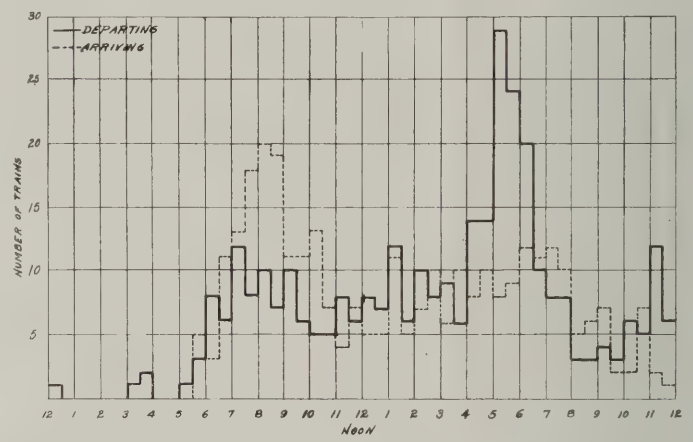



Fig. 3.—Diagram Showing Number of Trains Arriving and Departing Each Half-Hour from North Station, Boston. (June 20, 1910.)

| | |
|---|---|
| Power house | $ 6,000,000 |
| Transmission lines and overhead contact system | 3,850,000 |
| Suburban terminal shops and inspection facilities | 1,417,000 |
| Heavy repair shops | 400,000 |
| Electric locomotives | 6,725,000 |
| Spare parts for electric locomotives | 336,250 |
| Multiple-unit motor cars | 6,960,000 |
| Multiple-unit trail cars | 5,014,100 |
| Spare parts for multiple-unit cars | 299,352 |
| Signalling | 1,750,000 |
| | $32,751,702 |

The first item, $6,000,000 for a power house of 60,000 kilowatt capacity is a reasonable estimate. But, is it necessary to build a power house at all?

Figs. 2 and 3 show the number of trains arriving and departing each half hour from the South Station and the North Station respectively, the former taking in the trains of the New Haven as well as those of the Boston and Albany.

These diagrams give us some measure of the energy required to propel the trains.

There is a disagreeable peak between 5 and 6 p. m. in both cases, which might have to be taken care of by a storage battery or some similar method. Except for this the load is a very acceptable one for the power house of any lighting company.

Indeed, except for these two peaks, the furnishing of the energy for this train service forms a very interesting addition to the output of the lighting company, and it seems almost certain that the latter being able to work its machinery more advantageously, will sell its electric energy to the railroad company at a very reasonable price, possibly cheaper than the railroad company could ever produce it in its own station.

It would therefore seem wise from more than one viewpoint to consider buying the current rather than produce it, and the $6,000,000 item may be cut out.

To understand the next items it is nceessary to find out what it covers.

A detailed estimate shows that it includes transmission lines and overhead contact system for the following lengths of track:

| | |
|---|---|
| 15.46 miles of four-track road, at $40,000 per mile | $ 618,400 |
| 128.07 miles of double-track road, at $20,000 per mile | 2,561,400 |
| 32.46 miles of single-track road, at $7,000 per mile | 227,220 |
| 110.745 miles of yard track at $4,000 per mile | 442,980 |
| | $3,850,000 |

If these are proper figures for the system proposed, then by all means choose a better system.

With the right kind of apparatus it is feasible to equip a mile of yard track for not over $2,000 to $2,500 and a mile of main line for not over $5,000 to $6,000 per track.

This item would thus be reduced to about $2,000,000, and there are plenty of contractors who would be glad to get the job at that figure.

It is not stated in detail what size terminal and heavy repair shops are included in the estimate and the next two items will therefore go undiscussed.

The item locomotives is made up as follows:

| | |
|---|---|
| 113 light passenger locomotives at $40,000 | $4,520,000 |
| 49 heavy passenger locomotives at $45,000 | 2,205,000 |
| | $6,725,000 |

This number of electric locomotives seems exceedingly high, especially when it is noted that the number of steam locomotives reported released by the substitution of electricity for steam is only 88.

Without going into great detail it is difficult to accurately determine this point. A careful consideration of the service leads one to believe that, properly ar-

ranged for electric operation, it could be handled by 48, surely not more than 70 electric locomotives.

Locomotives of a type well suited for this service can be bought for $35,000 apiece. The item electric locomotives thus reduces to $2,450,000.

This automatically reduces the next item, spare parts, to $122,500, as this item is estimated to be 5 per cent of the item locomotives.

The item multiple-unit motor cars covers 232 cars at $30,000 = $6,960,000, the item multiple-unit trail cars, 377 cars at $13,300 = $5,014,100.

These numbers also seem very high. Motor and trailer cars, each with a seating capacity of 75, are together to take the place of 391 passenger coaches which are to be released. One would say that 150 motor cars and 250 trailer cars would be ample, and this would make these two items $4,500,000 and $3,325,000, respectively, leaving the unit price per car as it is.

The item spare parts for multiple-unit cars, being estimated at 2½ per cent of price of cars, is thus automatically reduced to $195,625.

Amended as above, the total estimate in the case of the New Haven Railroad foots up $16,160,125 for electrifying 461 miles of track, or about $35,000 per mile of track. Experience elsewhere shows this to be a conservative figure and if proper equipment is chosen the work can certainly be done within this amount.

The Boston & Albany Railroad, by leaving out the power house, can save about $2,250,000. Otherwise there is not much to be said about the Boston and Albany estimate.

Omission of the power house reduces this estimate to $4,163,300 for electrifying 128 miles of track, or about $32,500 per mile of track, a figure which checks remarkably well with the $35,000 found above for the New Haven.

Taking the cost of electrification as $16,160,125 in the case of the New Haven and $4,163,300 in the case of the Boston and Albany, the new fixed charges might be said to be about $1,500,000 and $400,000 respectively.

Following the English examples cited above, the annual increase in revenue after electrification might well be estimated at from 13 to 20 per cent. Taking only about $1,000 per mile of track—or approximately 10 per cent—per annum, the new fixed charges will be covered out of the new revenue alone from the fourth year on, leaving entirely out of consideration the large economies in cost of operation which electricity as motive power always brings about.

Looked at in this way, the question of terminal electrification does not seem so hopeless after all, but we should like to go on record as entirely approving the sentiment expressed by Mr. McHenry, namely, that the best results will doubtless be obtained if the substitution of electricity for steam is at first restricted to a few of the more important routes, subsequently extending the system as rapidly as consistent with the financial conditions and the public needs.

# The Turning of the Tide

Until very recently the Westinghouse Electric & Manufacturing Company's claims in trunk line electrification matters were based almost exclusively on the single-phase alternating current system of electric traction.

Not indeed because this was the only kind of equipment manufactured by that company. On the contrary, it has turned out some exceedingly good examples of other kinds.

But—to hear the Westinghouse representatives talk—the single-phase system had the others all beat a mile, and some more. The single-phase system—according to them—was the only system that was universally applicable to all cases of trunk line electrification. Consequently they recommended it everywhere and for all purposes.

In fact, they finally claimed that no other system should be considered by anybody, and they proposed in all earnestness that the single-phase alternating current system should be universally adopted as the only true method for electrifying railways.

That seems to have been the turning point.

Shortly after that, they apparently reached the conclusion that they had pinned their faith to the wrong idea, and that single-phase equipment as a general cure-all was a snare and a delusion.

At least, during the past few weeks they have begun to talk entirely different.

Before that, we and others were frowned upon for daring to suggest that there was a place for every one of the three or four well known systems of electrification.

And, when we stated that good engineering consisted in finding the proper place for each type of equipment, we were treated as heretics.

Now, the Westinghouse Company proclaims the identical thing.

It makes good reading to follow a highly interesting set of advertisements on "Electricity in Heavy Railroad Service" which began to appear in technical papers shortly after New Year and at the time of this writing is still running.

Let us abstract, and make some comments as we go along.

On January 6th:

"Railroad men can no longer consider electric traction unsuitable for use in ordinary main line service."

"The 'Electrification Talks' which began herewith and will follow in succeeding issues contain, in plain language, brief reviews of electric systems from the viewpoint of practical railroad men."

"Increased capacity and earnings must be the measure of the march of progress, and it is notable that discussions of electric operation are becoming considerations of cost and practical economy rather than disputes as to favorite systems."

Bravo! This is a most excellent beginning!

"The introduction of the epoch-making single-phase

railway apparatus of the Westinghouse Electric & Manufacturing Company has associated the words *"Single-Phase"* and *"Westinghouse"* to such an extent that, in the minds of many otherwise well-informed persons, the Westinghouse Company is believed to advocate single-phase electrification for steam roads, as opposed to any other system."

It must be left to advertisment writers to use from time to time big words, like "epoch-making" etc. It was however, not the epoch-making feature of single-phase apparatus which linked it with the name Westinghouse, but the continued aggressive assertions of the Westinghouse Company's own engineers on this subject.

"There are three established systems of railway electrification and the Westinghouse Company supplies apparatus for *any* plan which a study of the conditions indicates to be best suited to the situation involved."

That is what we have been working for all along and we are glad it has come at last.

"That the Westinghouse Company holds no brief for any particular system is evidenced by the fact, that it has executed the *most extensive and important work* yet done in *heavy railroad electrification*, employing, in its appropriate place, Direct Current Apparatus, Single-Phase Alternating Current Apparatus and Three-Phase Alternating Current Apparatus."

"In practical employment of *each* of the three electrical systems *the most important installations in the world* use Westinghouse apparatus."

Here again we see the hand of the ad. writer. The italics are his. We think it might have been better had he been able to lay stress on the word "in its appropriate place," and if in the future everybody will use due care to choose the "appropriate" apparatus for each place, there will be no more disappointments in railroad electrifications.

"The wide experience of Westinghouse engineers with *all* operative systems and conditions is at the disposal of railroad men and insures equipment suited to the work."

This is what we like to hear, and thus closes the first installment, or talk, with a highly suggestive remark and leaves us in a very receptive mood for what is to come.

On January 13th (Talk No. 2—Direct Current):

*"Net earnings* must be the first and final measure by which application of electric power on railroads will be judged. The cost of the work and the probable returns therefrom, whether direct or indirect, must determine the manner of electrification."

Very well put, indeed!

"The railroad operator wants to know:—

"Will electric motive power haul my trains more cheaply and reliably than steam?

"Will electrification permit present operating methods to be so improved as to effect savings?

"Will electric service contribute to the building up of passenger and freight traffic in the district served, and increase earnings?"

"The experience of some of our largest roads indicates that such results are entirely possible."

"Increasing attention to the practical end of such problems is necessary and certain."

Most excellent! The only pity is, that the answer to the above questions is not more specific. May be, there is a surprise in store for us in one of the next issues.

"*The Direct Current System* is admirably suited to a great variety of railroad work."

"*In large Terminal and Subways* with a heavy load factor and where third rail construction is admissible and economical, Direct Current apparatus is especially useful."

"*Westinghouse Direct Current Railway Motors,* for any desired voltage and for both locomotives and motor cars, are extremely simple, rugged in construction, and of the highest efficiency ever achieved."

All strictly true, except for the very last statement, which is apparently the outcome of the ad. writer's poetical license. Not from a spirit of criticism, but with due regards to actual facts, we call attention to the fact that the Westinghouse Company itself has built motors of other types which excel in efficiency its direct current motors.

"*The Pennsylvania Direct Current Locomotives* are the largest and most powerful ever built."

"The Westinghouse Electric & Manufacturing Company builds the best Direct Current, Single-Phase and Three-Phase Railway Apparatus known."

"Its engineering experts in each of the three systems are unexcelled."

"The *largest installations* of each type *in the world* use Westinghouse appliances."

We leave it to the well-informed reader to judge whether the superlatives are properly applied or not. The crux of the matter lies in the fact that the Westinghouse Company builds the three kinds of railway apparatus and quite plainly wants to make it known that such is the case.

On January 20th. (Talk No. 3—Single-Phase):

"The relative merits of Single-Phase and Direct Current Systems have been argued in partisan technical discussions at such length that an operating railroad official who is not electrical would not attempt to follow the dispute."

For that reason he lost interest in the subject.

"The broad minded consulting engineers today realize that all three electrical systems have proven successful and profitable in main line service here and abroad, where the conditions of operation were properly studied."

The broad minded ones realized this not today but long ago.

"Selection of an appropriate equipment is no longer a matter of grave difficulty."

It probably never was, to those properly trained.

"The great electrical companies of today maintain engineering departments wherein economical, geographical and traffic conditions are made special studies and the advisability of substitution of electricity for steam is readily determined."

This phase of the question can much better be handled by an independent engineer.

"*Transmission and distribution* of energy from power plant to moving train is simplified and economized by the Single-Phase Alternating Current System."

"The need of costly substations with moving machinery and attendants is eliminated."

These are the true advantages of the single-phase system.

"*The high efficiency* thus obtained in power transmission and distribution more than compensates for a somewhat low efficiency in motors."

In some cases it does, in others it doesn't. The truth is that the total efficiency is made up of the product of transmission efficiency and motor efficiency. In some cases the former is more important, in others the latter. To find out which it is in particular instances, is the province of the consulting engineer.

This third talk closes with a repetition of the statement:

"The Westinghouse Electric & Manufacturing Company builds the best Direct Current, Single-Phase and Three-Phase Apparatus known, etc."

And thus emphasizes the fact previously stated.

We presume that there will be a talk No. 4 on January 27th, and that it will treat on Three-Phase Equipment, but we have to go to press before that time and must therefore postpone further discussion until another issue.

We have pointed out some small flaws in the wording of these talks, mainly due as far as we can see to too great enthusiasm on the part of the ad. writer, but the spirit of the whole thing is fine.

The Westinghouse Company admits that it has made a mistake in the past by trying to impose the single-phase system on an unwilling world, and it is now ready to give all kinds of equipment an equal show and to aid in the development of same and in the choice of the best kind of apparatus for each place.

We have in the past been several times bitterly attacked by representatives of the Westinghouse Company when we stood up for "the open door" policy.

We bear the company no ill on this account. We have always endeavored to defend our viewpoint in proper form and to the best of our ability, and today, taking the company's statements as a sincere expression of its present attitude, not as a guise to manoeuvres of another kind, we are perfectly willing to bury the hatchet, and to work

"Everybody all the time for everything electrical, so long as it is in its proper place."

## LONG DISTANCE POWER TRANSMISSION BY HIGH TENSION DIRECT CURRENTS.

Most of us are accustomed to unconsciously link in our minds long distance power transmission with three-phase alternating current equipment. In America three-phase currents are used almost exclusively for this purpose.

It will therefore no doubt come as a surprise to many to learn that work has just been started on a European transmission line that will convey 28,000 horse power over some 120 miles by means of direct currents at a pressure of 127,000 volts.

Years ago the Compagnie de l' Industrie Electrique et Mecanique, of Geneva, Switzerland, installed a transmission line from a water power plant near Moutiers in the Savoyan Alps to Lyons on the principle of the well-known Thury constant-current direct current system.

The original station at Moutiers contained five generating sets. Each set had an output of 1,600 horse power and consisted of two double generators coupled to a water turbine. Each set produced a current of 75 amperes at 14,400 volts.

Thus the total rating of the generating station was 8,000 horse power, of which 6,400 horse power were transmitted at 57,000 volts to Lyons, a distance of 110 miles over two copper wires 0.36 inch in diameter.

At Lyons the current drives eight 725 horse power motors, six of which are coupled to direct-current generators for supplying energy to the Lyons street car system. The other two drive alternators for light and power service.

The excellent results which have been obtained from this line during its four years' working, from the point of view of simplicity, regularity, safety and ease of upkeep, have determined the supply company to carry out the following extensions:

The erection of a new station at Bridoire, which will contain four 2,000 horse power generators supplying a current of 150 amperes at 9,125 volts each.

The erection of a station at Bozel, with three 4,000 horse power machines supplying 150 amperes at 18,250 volts each.

The installation at the Vaulx-en-Velin substation in Lyons of five motors of the same type as the generators, each motor with a rating of 1,730 horse power.

The modification of the present line and apparatus to make it capable of taking 150 amperes.

It must be understood that the Thury system is based on the transmission of a constant current, in this case 150 amperes, at a variable voltage.

When the three generating stations will all be operating together, they will be coupled in series one behind the other. They will all supply 150 amperes and the voltage will rise from a very low value at low load to about 127,000 volts at full load of 28,000 horse power.

## ELECTRIC WORK IN THE HOOSAC TUNNEL.

The installation of electric equipment in the Hoosac tunnel is proceeding merrily, but it is surrounded by certain difficulties, the overcoming of which is not without interest.

To support the overhead contact line, brackets or similar contrivances have to be fastened to the roof of the tunnel. This means that holes have to be drilled into the rock. If the tunnel were not in operation, this would be easy enough. With trains passing through the tunnel at relatively frequent intervals, the matter assumes an entirely different aspect.

To protect the men from the volumes of smoke emitted by the passing trains, they are placed in tents which are set up on the roofs of the cars of their working train. These tents are supplied with air taken from a point near the floor of the tunnel and carried to the tents by means of air compressors.

There are two tracks throughout the length of the tunnel, which is 4¼ miles.

The work train occupies one track while the regular trains continue to use the other.

The work was begun at the west or North Adams end and it has now proceeded considerably over a mile.

# SHOP SECTION
EDITED BY
GEO. W. CRAVENS

## SOME FEATURES OF SYNCHRONOUS MOTOR OPERATION.

Each type of motor on the market is better suited for special conditions than any other type of motor, and where large motors are required for conditions that call for practically continuous operation the synchronous motor presents several advantages over induction motors. These advantages are exact regulation of speed, high efficiency, control of power factor and the ability to operate directly on high potential lines.

### Speed.

The synchronous motor, as its name indicates, is so constructed that it runs at the same frequency (cycles per second) or revolutions per pole as the generator which supplies the circuit, the speed being independent of voltage and load. This being the case, it is important that the speed of the engine driving the generator be as uniform as possible, both as to R. P. M. and to angular velocity per revolution. With slow speed generators having a large number of poles, it is especially important, because any variation in speed is multiplied, in the variation in frequency of the current, by one-half the number of poles.

The fly wheel capacity of synchronous motors is sufficient to absorb considerable energy, and they tend to run at constant speed, so, if the source of power is pulsating there will be heavy fluctuating currents set up between the motors and the generators. This will interfere with the operation of lights on the system and may greatly reduce the capacity of the motors.

### Efficiency.

Practically all alternators may be used as synchronous motors, and can receive the same apparent kilowatt input that they would deliver as generators, and with about the same efficiency and heating. When operating a generator as a motor, it should be run at its no load voltage.

A synchronous motor will carry any reasonable overload without dropping out of step, or synchronism, providing the voltage remains normal, because the torque and power of such a motor depend almost entirely upon the voltage of the supply circuit. When out of step the torque of synchronous motors is limited, so they cannot be used to start their full loads.

Single phase synchronous motors will not start alone, but two phase and three phase motors have enough torque to start and run up to synchronous speed unaided.

These motors are very highly inductive when starting or running out of synchronism, and a serious drop in the potential of the system may be caused by the amount of current taken. The starting current at normal voltage will be from 2½ to 5 times full load current, depending upon the motor. For this reason a compensator is usually placed in the circuit to reduce the voltage on the motor when starting. About 70% of full load current should start a motor with no load and bring it up to speed or very near it in one minute.

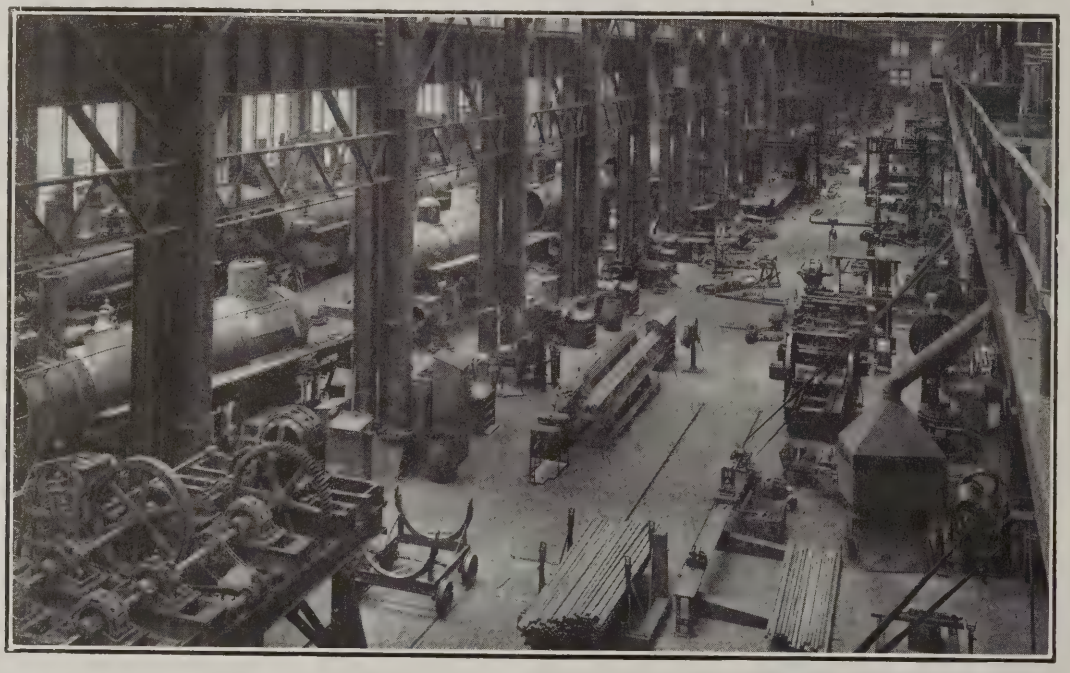


Fig. 1.—Interior View of Locomotive Shop, N. Y., N. H. & H. R. R., Readville, Mass.

### Power Factor.

The power factor of an induction motor is fixed by its design, but its current is always lagging, whereas the power factor of a synchronous motor may be varied to give either a lagging or a leading current by varying the strength of field excitation. A weakened field excitation produces a lagging armature current like that in an induction motor, while a stronger excitation produces a leading armature current like a condenser.

The synchronous motor may thus be run with a min-

imum current and maximum power factor and can be used to compensate for inductive loads in other parts of the system. If the same amount of power be put in the form of synchronous and induction motors on a system, the lagging current of the induction motors may be overcome by over-exciting the synchronous

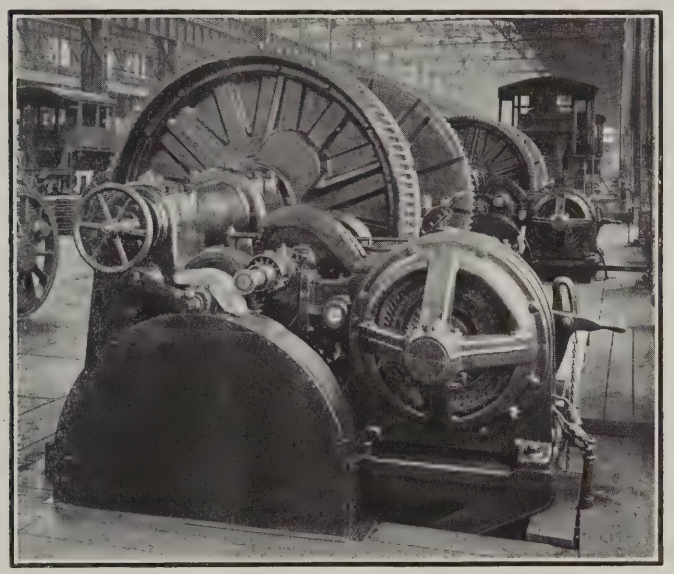


Fig. 2.—75 H. P. Induction Motors Geared to 90 Inch Double Wheel Lathes.

motors sufficiently to give an equal leading current and bring the power factor up to 100%.

Synchronous motors, like A. C. generators, are rated on the basis of their apparent kilowatts, not the actual, so there should be enough margin in capacity to take care of the increased current if the motor is to

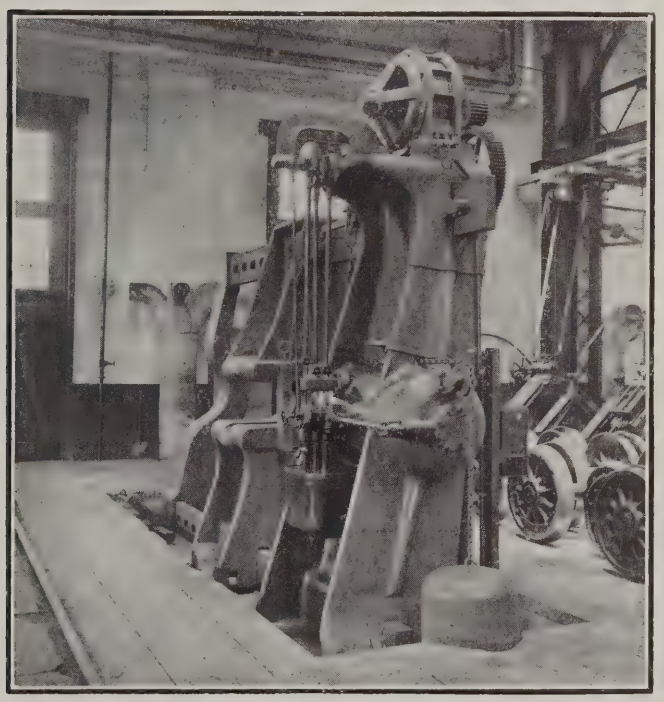


Fig. 3.—25 H. P. Induction Motor Geared to 600 Ton Wheel Press.

be over-excited at full load. A motor used to supply leading current is called a rotary condenser.

**Voltage.**

The armature of a synchronous motor may be wound for any potential that a generator of similar construction may produce. When starting a synchronous motor, the relation between the armature and field windings is the same as that between the primary and secondary of a static transformer, so it is important that the field be wound for not more than 125 volts. Motors wound for higher field potentials are not desirable on account of possible trouble in

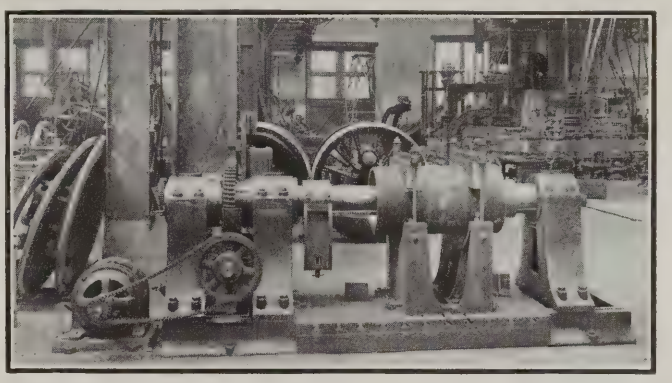


Fig. 4.—Cylinder Borer Driven by 7½ H. P. Induction Motor.

fields, collector rings and brush holders due to the high induced voltage.

It should be understood that synchronous motors require direct current excitation for their fields, the same as alternating current generators. It is very common practice to mount the exciter on one end of the motor shaft, although separate exciting circuits are provided in many cases. In all cases, the speed of the motor should be brought up to synchronous or a little

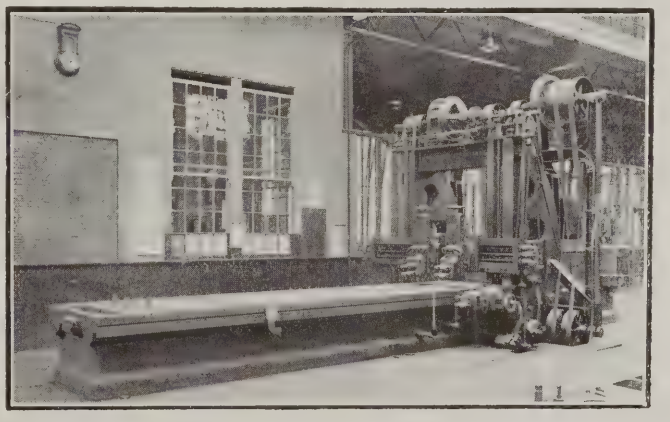


Fig. 5.—35 H. P. Induction Motor Direct Connected to 5 Ft. x 5 Ft. x 20 Inch Planer.

above before the exciting current is put into the fields. This may be done by starting as an induction motor and throwing over, or by the use of a separate small motor.

Synchronous motors should not be switched from one generator circuit to another unless they are in synchronism. It is better to parallel the generators first and then cut out the first one so as to not throw the motor out of step. The same rules govern reversing synchronous motors as for induction motors.

## THE NEW HAVEN SHOPS AT READVILLE,

*(Continued from January number.)*

The principal features and size of these shops were mentioned in the preceding article, and data from tests of more of the principal machine tools are given here. It is especially interesting to note the comparatively small amounts of power actually required to operate most of the machines.

A good general idea of these shops may be gained from the illustrations herewith. Fig. 1 gives a view

of the machine shop (on the right) with a glimpse of the erecting shop (on the left). The gallery along the right side is 35 ft. wide and is used for light manufacturing and repair work, and is served by the cranes.

The compact arrangement of the motors and gearing on the wheel lathes is shown in Fig. 2. The protecting covers over the gearing are worthy of note, as is also the placing of the motor on top of the wheelpress in Fig. 3. Some machines are so built that it is not practicable to mount the motors directly upon them, and Fig. 4 shows how this condition was met by placing the motor at one end of a cylinder boring machine and driving through a silent chain.

Another method of connection and drive is shown on the planer in Fig. 5. In this case the motor is coupled to a countershaft on top of the machine and drives the planer through belts, the same as though the counter shaft was separate from the machine. The fly wheel on this shaft helps the motor by giving up some energy at the moment of reversal of the bed of the planer.

---

NO. 9 PUNCH AND SHEAR (HILLES & JONES), 15 H.P. MOTOR

| | | |
|---|---|---|
| Running light | 3. | |
| Punching 2 in. hole in ¼ in. boiler plate | 5. | Max. |
| Punching 2 in. hole in 1½ in. wrought iron | 22. | |
| Shearing 4 in. by 2½ in. hammered iron | 10. | |

NO. 3 SHEAR (HILLES & JONES), 5 H.P. MOTOR

| | | |
|---|---|---|
| Running light | 0.3 | |
| Shearing round steel ½ in. diam. | 0.8 | Max. |
| Shearing round steel ¾ in. diam. | 1.1 | |
| Shearing boiler plate ⅝ in. by 2½ in. | 2. | |
| Shearing boiler plate ⅜ in. by 1½ in. | 1.2 | |

SPLITTING SHEAR (LENOX MACHINE CO.), 7½ H.P. MOTOR

| | |
|---|---|
| Running light | 0.4 |
| Cutting ¼ in. boiler plate | 1.7 |

Cutting speed—7.2 ft. per min.

10 FT. BENDING ROLLS (HILLES & JONES), 10 H.P. MOTOR

| | |
|---|---|
| Running light | 1.2 |
| Bending ½ in. boiler plate, average | 2.8 Max. 4.4 |

Boiler plate was 6½ ft. wide and was bent to a radius of 30 in. in 5 rollings.
Rolling speed—5.6 ft. per min.

63 IN. BOSTON CUPOLA AND FORGE BLOWER, 30 H.P., FORM L INDUCTION MOTOR

This blower furnishes air for one flange fire, two flue fires, and a four burner Ferguson annealing furnace, made by the Railway Materials Co.

| | |
|---|---|
| All full blast | 13.8 |
| Two flue fires only | 9.5 |

NO. 7 BLOWER (STURTEVANT), BULLDOZER (AJAX), 35 H.P., 500 R.P.M. MOTOR

Blower furnishes air for 5 furnaces.

| | |
|---|---|
| Blower with 3 furnaces operating | 16.3 |
| Blower and Bulldozer | 28.3 Max. |

Bulldozer was making 2-90 deg. bends on ¾ in. by 3 in. iron.

STURTEVANT BLOWER, 35 H.P. MOTOR

Blower furnishes air for one double furnace, four single furnaces and five double forges.

| | |
|---|---|
| 3 single furnaces at work<br>1 double furnace at work | 17.6 |
| 3 single furnaces at work<br>1 double furnace at work<br>1 double forge full vent | 18.6 |

BLOWER (BUFFALO), EXHAUSTER (BUFFALO), FOR 20 FORGES AND 2 FURNACES, 50 H.P., 500 R.P.M. FORM L INDUCTION MOTOR

| | |
|---|---|
| 11 forges and 2 furnaces in operation | 21.5 |

NO. 3 SHEAR (HILLES & JONES), 10 H.P. MOTOR

| | | |
|---|---|---|
| Running light | 1. | |
| Shearing 1½ in. wrought iron | 5.5 | Max. |
| Shearing 2¾ in. wrought iron | 6. | |

5 FT. 6 IN. RADIAL DRILL (NILES, BEMENT & POND), 5 H.P. MOTOR

| | |
|---|---|
| Running light | 1.2 |
| Drilling ¾ in. hole in steel, feed 0.67 in. per min. | 1.5 |
| Drilling 2½ in. hole in steel, feed 0.075 in. per min. | 1.8 |

MILL SHOP NO. 1

SWING CUT-OFF SAW (ROGERS), 3 H.P. MOTOR

| | |
|---|---|
| Running light | 0.74 |
| Cutting 2 in. by 12½ in. spruce | 2.4 |

Size of saw—19 in.
Speed—2080 r.p.m.

SWING CUT-OFF SAW (ROGERS), 3 H.P. MOTOR

| | | |
|---|---|---|
| Running light | 0.9 | |
| Cutting 5 in. by 8 in. hard pine | 6. | Max. |
| Cutting 2 in. by 10 in. hard pine | 5. | |

Size of saw—18 in.
Speed—1840.

RAIL SAW (NEWTON), 7½ H.P. MOTOR

| | |
|---|---|
| Running light | 0.56 |
| Sawing 6 in. steel rail, average | 1.6 Max. 2.4 |

Feed—0.21 in. per min.
28 in. saw, 5.15 r.p.m.

RAIL BENDER (WATSON & STILLMAN), 15 H.P. MOTOR

| | |
|---|---|
| Running light | 1. |
| Bending 79 lb. rail to 24 ft., 11¼ in. radius | 8. |

Speed of rail—100 ft. per min.

15 IN. SLOTTER (DILL), 5 H.P., 1500 R.P.M. MOTOR

| | |
|---|---|
| Running light | 0.4 |
| One ⅜ in. cut, 1/64 in. feed on steel | 0.9 |

Tool steel—Mushet high speed.
Strokes per minute—23.

ELEVATOR, 5 H.P. MOTOR

| | |
|---|---|
| Motor running light | 0.56 |
| Elevator up with one man | Pump back on line |
| Elevator down with one man | 4.2 |
| Elevator up with 1400 lbs. | 1.2 |
| Elevator down with 1400 lbs. | 2.2 |

24 IN. EXTRACTOR, 3 H.P. MOTOR

| | |
|---|---|
| Extractor filled with oily waste | 0.96—0.88 |

Speed of extractor—1080 r.p.m.

NO. 3 GAINER (WOOD), 10 H.P. FORM L INDUCTION MOTOR

| | |
|---|---|
| Running light | 2.4 |
| ½ in. by 1½ in. gain in hard pine | 4.4 |
| 2 in. by 4½ in. gain in hard pine | 7.2 |

NO. 2 FORGING MACHINE (AJAX), 10 H.P. FORM L INDUCTION MOTOR

| | |
|---|---|
| Running light | 1.6 |
| Punching 5/16 in. hole in a 1 9/16 in. rivet | 5.0 Max. |

NO. 5 FORGING MACHINE (AJAX), 20 H.P. FORM L INDUCTION MOTOR

| | |
|---|---|
| Running light | 3.7 |
| Loaded | 16.1 Max. |

Load consisted of gathering a 1⅞ in. hemispherical head on a 1⅛ in. rivet.

GROUP (GALLERY), 7½ H.P. MOTOR

| Machines | Load | Kilowatt Input |
|---|---|---|
| 1 Two spindle irregular moulder (Carey) | Running light | |
| 1 39½ in. band saw (Carey) | Running | |
| 1 Double saw table (Carey) | Running | 7. |

When test was made saw was ripping 2 in. pine and saw bench ripping 2 in. oak.

GROUP, 10 H.P. MOTOR

| | | |
|---|---|---|
| 4 Flue cutters | 2 Running light<br>2 Running | |
| 1 Flue welder | Running | |

GROUP, 10 H.P. MOTOR

| | | |
|---|---|---|
| 1 28 in. Vertical drill (Blaisdell) | Running | |
| 1 40 in. Vertical drill (Bement) | Running | |
| 1 38 in. Vertical drill (Prentice) | Running | |
| 2 34 in. Lathes (Putnam) | 1 Running | |
| 5 22½ in. Vertical drills (Barnes) | 1 Running | 6.2 |

GROUP, 15 H.P. MOTOR

| | | |
|---|---|---|
| 3 24 in. Lathes (Reed) | 2 Running | |
| 1 40 in. Vertical drill (Bement) | | |
| 1 42 in. Boring mill (Bullard) | Running | |
| 1 24 in. Shaper (Stockbridge) | | |
| 1 15 in. Slotter (Betts) | | |
| 1 18 in. Slotter (Putnam) | Running | |
| 1 30 ton Arbor press (Chambersberg) | | 8. |

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## SOME POINTS RELATING TO RAILWAY SHOP POWER PLANTS.*

The railway repair shop includes the following elements: The locomotive department, consisting of machine shop, erecting shop, boiler shop, blacksmith shop, and woodworking shop. Usually there is included in the same plant with the locomotice department a car department, which in its completeness includes a freight car shop, a passenger car shop, a paint shop, and a planing mill. In most cases, also, the shop plant is located at some point where there is an engine terminal; this terminal being supplied with power from the shop power plant. The passenger car department is very often not included in the main plant; this is also true of the freight car department, although it is advisable, from the engineering standpoint, that they should be, on account of the fact that the refuse from the manufacture and repair of wooden cars can be used in the power house, effecting a large saving in coal. In a particular case, from a freight car shop having a capacity roughly of fifteen heavy repair cars per day, the shavings supplied to the power house boilers had a heating value sufficient to supply 350 boiler horsepower. It also supplied refuse wood good for fuel to the value of $15 per day. This fuel is much more than would be needed to supply power for the car department alone.

*Extracts from a paper presented at a recent meeting of the Southern and Southwestern Railway Club by Mr. E. M. Rhett, electrical engineer for the Central of Georgia Railroad.

# The 1910 Edison Storage Battery

By WALTER E. HOLLAND

*(Continued from the January issue.)*

No serious or permanent injury has ever been known to come from low-rate charging, and the discharge will usually recover normal characteristics when the cell is again worked regularly at normal rate. If not, then overcharging at normal rate and discharging to complete exhaustion will certainly re-establish normal conditions. Secondly, it should be kept in mind that although excessive heating does no immediately-apparent harm to the battery, continuous working at high temperature will have an injurious effect tending to shorten its life.

### Internal Resistance.

What the true ohmic resistance of a storage cell is need not be known; the virtual internal resistance, that

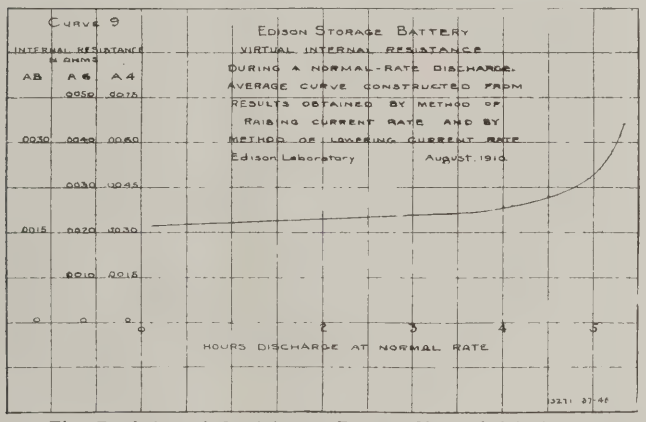



Fig. 7.—Internal Resistance During Normal Discharge.

is the factor which is effective in causing internal dissipation of energy, is the value of practical importance. The prescribed method of finding this is to momentarily open the switch at intervals during a discharge and read the electromotive force; then the difference between the value thus found and the potential difference while current is passing would represent the I R drop in the cell due to its effective resistance,

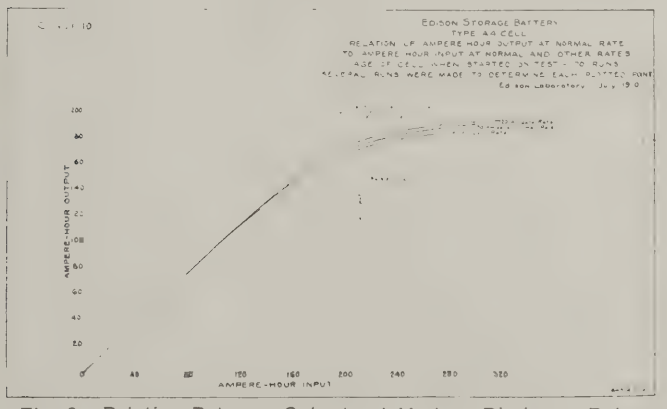

Edison Storage Battery
Type A6 Cell
Relation of Ampere-Hour Output at Normal Rate
to Ampere-Hour Input at Normal and Other Rates
Edison Laboratory, July, 1910
Ampere-Hour Output
Ampere-Hour Input

Fig. 8.—Relation Between Outputs at Various Discharge Rates.

and this value divided by the current rate would give the virtual internal resistance at the given point of discharge. This method is hard to apply because when the switch is opened the interruption of current changes the electromotive force to such an extent that the voltmeter needle continues to rise for some time afterward, and the true value of the E. M. F. is very difficult to determine.

A better scheme is to reduce the current to a lower value instead of interrupting it entirely, and dividing the difference between the voltage at the two rates by the change of current. Obviously the same result can be achieved through momentary increases of current; and to get the most reliable test the methods should be combined and the current worked both ways on the same discharge. Thus, taking the concrete case of an "A6" cell discharging at 45 amperes, the current should be changed to 15 amperes and 75 amperes alternately for, say, half-minute periods every twenty or thirty minutes. Then the difference between the voltage at 45 amperes and that at either the low or high rate, divided by 30 amperes would give the true virtual internal resistance for the particular conditions. Figure 7 is a curve of internal resistance obtained by this method; it shows the average values for an Edison cell discharging at normal rate under ordinary conditions.

### Output and Efficiency.

The output of an Edison cell is determined by the capacity of the positive or nickel electrode, as the individual electrode curve of the Figure 5 shows. The Company has found it best in every way to design the cell with a sufficient allowance of iron active material to give considerable excess capacity to the negative electrode.

Cells do not have as high capacity when new as

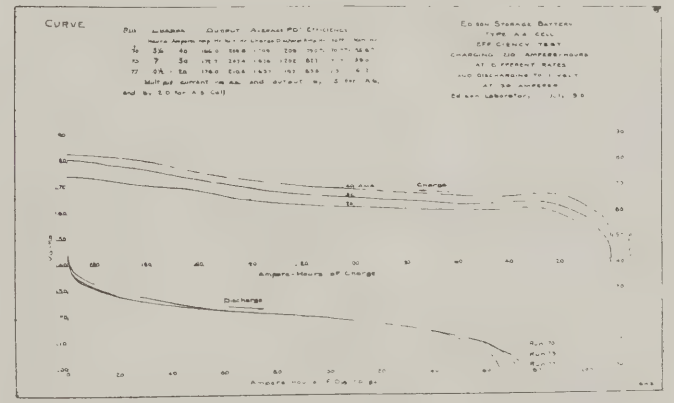



Fig. 9.—Efficiency Curves.

after some weeks of use. The betterment comes from an improvement of conditions in the nickel electrode which is brought about by regular charging and discharging. Overcharging expedites this self-formation and is recommended by the Company. Every cell manufactured is given three overcharge runs before leaving the factory, and this is always sufficient to bring the capacity up at least to the rating. The accretion of capacity continues for twenty, or more, runs, and no results can be considered typical which are obtained in tests made earlier than the twentieth run. The term "run" is used to mean a full charge and complete discharge.

The output and efficiency of a cell, working at ordinary temperatures, depend upon three factors—the rate of charge, the amount of charge, and the rate of discharge. Fig. 8 shows the relation of current output to current input when a cell is given different length of charge at 2/3, 1, and 1 1/3 times normal

rate. It will be seen that for low inputs the efficiency is very high and practically the same for the different rates of charge. Further along the curves separate, the advantage being in favor of low-rate charging. Notice that the point taken as the normal input (210 ampere-hours for A4) comes pretty close to the sharpest part of the bend. Fig. 9 gives the character-

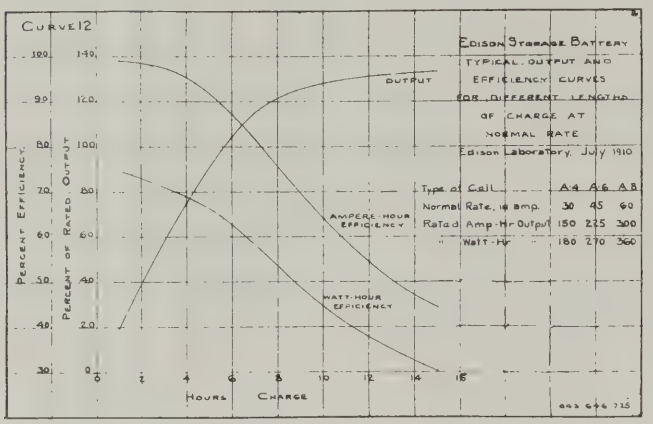



Fig. 10.—Typical Output and Efficiency Curves.

istic curves with output and efficiency data for this normal input point.

The relations of current and energy output and of current and energy efficiency to the length of charge at normal rate are summarized in the curves of Figure 10. These curves show maximum efficiencies on short charge of practically 99% in ampere-hours and 75% in watt-hours, while on normal 7-hour charge the efficiencies are respectively 82% and 58%. It is often found advantageous (and economical, too) to work the battery at the lower efficiencies of a 9 or 10-hour charge, thus realizing exceedingly high output results.

Watt-hour efficiency is the product of ampere-hour efficiency and "volt efficiency"—the latter term being used synonymously with the term "coefficient of drop"

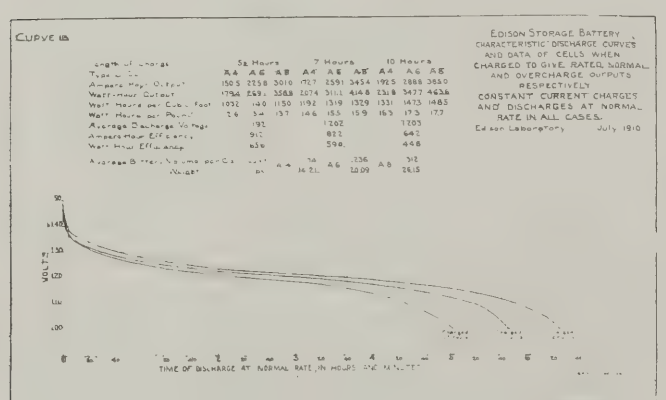

Curve 15
Edison Storage Battery
Characteristic Discharge Curves and Data of Cells When Charged to Give Rated, Normal, and Overcharge Outputs Respectively
Constant Current Charges and Discharges at Normal Rate in All Cases.
Edison Laboratory July 1910
Time of Discharge at Normal Rate in Hours and Minutes

Fig. 11.—Characteristic Discharge Curves.

to express the relation of the average voltage of discharge to the average voltage of charge. The volt efficiency depends principally on the rates of charge and discharge and does not vary much under ordinary conditions. Charging and discharging at normal rate, its value will be close to 72% for any length of charge not extremely short or long; and this figure therefore represents the practical limit of watt-hour efficiency for normal-rate working. The watt-hour efficiency on any normal-rate test may be calculated accurately enough for all practical purposes by taking 72% of the easily determined ampere-hour efficiency. Decreasing the current rate increases the volt efficiency, thus raising th limit of possible watt-hour efficiency.

The Edison cell has an air-tight cover, a valve being provided for the escape of gas. Practically no water is lost by evaporation, therefore, and a battery can be left idle for months without attention and there will be no danger of the solution getting low. Water is lost when a battery is working, however, and this results entirely from overcharging; for any current which is not used to effect the chemical changes at the electrodes goes to produce hydrogen and oxygen, the elements of water, which are emitted as gas. To replace this loss, pure water must from time to time be added. The figure of ampere-hour efficiency represents the proportion of a charge which goes to produce the desired chemical changes at the electrodes, therefore the balance is proportional to the loss of water. Thus from the curve, Fig. 10, we see that charging 7 hours at normal rate (210 ampere-hours input) the ampere-hour efficiency is 82% and charging 10 hours (300 ampere-hours input) it is 64%. The loss of water therefore would be represented by 18% of 210 = 38 ampere-hours in the first case and by 36% of

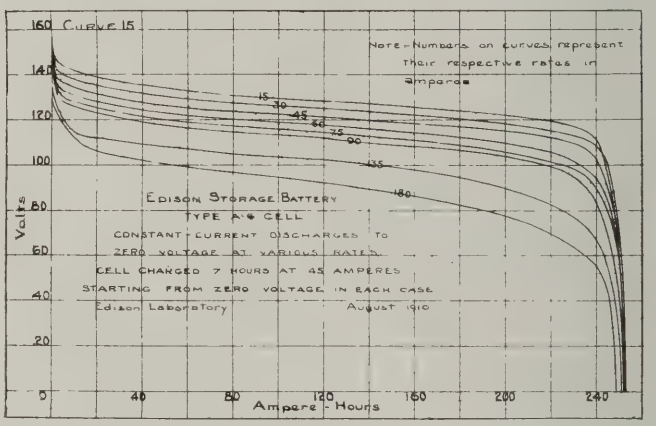

Curve 15
Note—Numbers on curves represent their respective rates in amperes
Edison Storage Battery
Type A-4 Cell
Constant-current Discharges to Zero Voltage at Various Rates.
Cell Charged 7 Hours at 45 Amperes
Starting from Zero Voltage in Each Case
Edison Laboratory August 1910
Volts
Ampere-Hours

Fig. 12.—Constant Current Discharge Curves at Various Rates.

300 = 108 ampere-hours in the second case—showing that a battery which is worked continually on 10-hour charges would require the addition of water about 3 times as often as one worked continually on 7-hour charges. This points to the possibility of reducing the amount of required filling to almost nothing in those cases where a battery can be worked on short frequent charges at high efficiency.

Fig. 11 shows characteristic discharge curves and

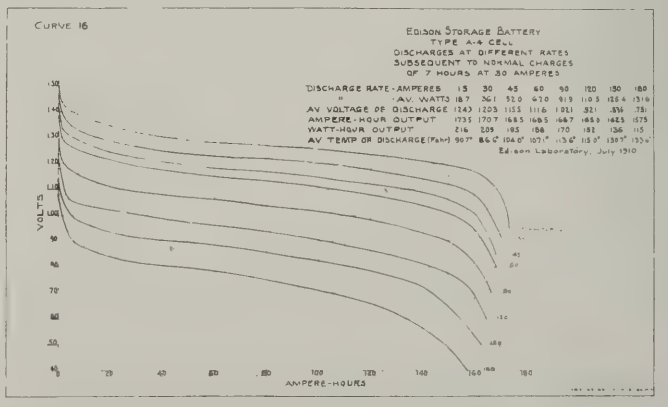

Curve 16
Edison Storage Battery
Type A-4 Cell
Discharges at Different Rates Subsequent to Normal Charges of 7 Hours at 30 Amperes
Edison Laboratory, July 1910
Volts
Ampere-Hours

Fig. 13.—Discharges at Various Rates.

data for a cell at its rated output, at its normal output and at its overcharge output. Note that only 5½ hours' charge at normal rate is required to obtain the rated output, and the efficiency under these condi-

tions is very high; while under the overcharge conditions exceedingly high output per unit-weight of battery is realized at a sacrifice of efficiency.

Although in most of the tests presented here the cells were charged at constant current, this was done only for the sake of convenience; and in practice it is really better to "taper" the rate in the familiar manner

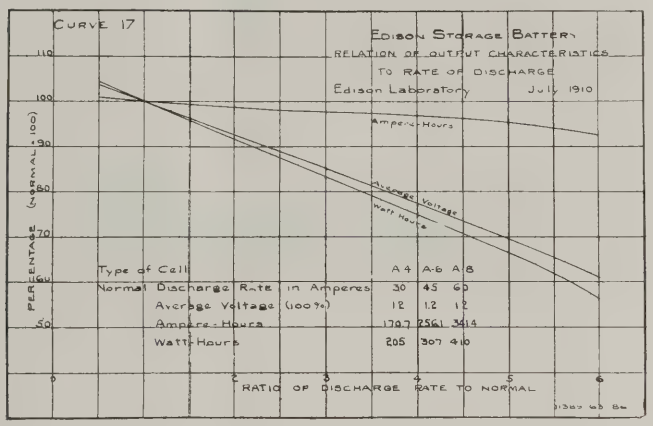

CURVE 17
EDISON STORAGE BATTERY
RELATION OF OUTPUT CHARACTERISTICS TO RATE OF DISCHARGE
Edison Laboratory July 1910
Ampere-Hours
Discharge Voltage
Watt-Hours
PERCENTAGE (NORMAL=100)
Type of Cell A4 A6 A8
Normal Discharge Rate in Amperes 30 45 60
Average Voltage (100%) 1.2 1.2 1.2
Ampere-Hours 1707 2561 3414
Watt-Hours 205 307 410
RATIO OF DISCHARGE RATE TO NORMAL

Fig. 14.—Relation of Output Characteristics to Discharge Rates.

of charging lead batteries. This is of especial advantage where the time on hand for charging is limited.

Constant current discharges of the Edison battery at no matter what rate are found to give a quite constant output figure if carried to very low voltage (see Fig. 12), and differ only as to average voltage, this being higher or lower according as the I R drop in the cell (depending on the I value) is little or much. The low voltage part of the curve cannot be considered useful, however; so the statement sometimes made that the ampere-hour output of the Edison battery is independent of the discharge rate is not strictly true. On the other hand, it would not be a fair test to terminate high-rate discharges at 1.0 volt or 0.9 volt, as is done usually in normal-rate tests, because this would

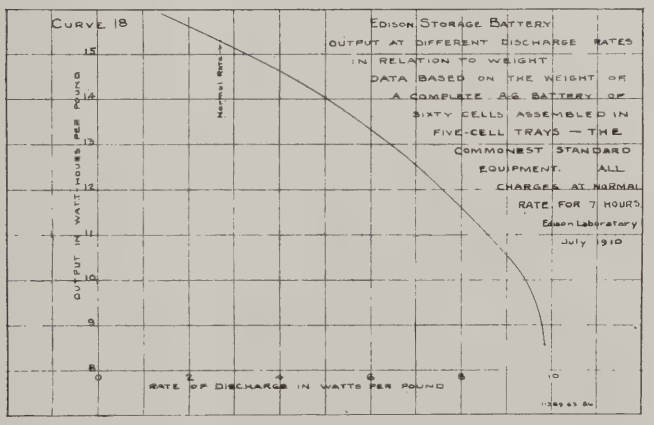

CURVE 18
EDISON STORAGE BATTERY
OUTPUT AT DIFFERENT DISCHARGE RATES
IN RELATION TO WEIGHT
DATA BASED ON THE WEIGHT OF A COMPLETE A-6 BATTERY OF SIXTY CELLS ASSEMBLED IN FIVE-CELL TRAYS — THE COMMONEST STANDARD EQUIPMENT. ALL CHARGES AT NORMAL RATE FOR 7 HOURS
Edison Laboratory
July 1910
Normal Rate
OUTPUT IN WATT-HOURS PER POUND
RATE OF DISCHARGE IN WATTS PER POUND

Fig. 15.—Relation Between Output and Weight.

not correspond to the same state of discharge; and the cell would start the next charge in a semi-charged condition, which would make the subsequent discharge abnormal. Also, it is possible to discharge at a rate so high that the very first volt reading will be lower in value than the above-mentioned regular terminating voltages. The author believes the fairest plan in this case is to discharge to successively lower voltage points as the rate is increased, each terminating voltage to be lower than the previous one by a value corresponding to the average increase of I R drop in the cell resulting from the increase of current. Thus, if the "A4" cell (whose average internal resistance, Fig. 7, shows to be .0037 ohm), is usually taken to 0.9 volt on a discharge at 30 amperes, the discharge should be carried 0.11 volt lower or to 0.79 volt when the rate is doubled to 60 amperes, because in that case the average increase of I R drop in the cell would be $30 \times .0037 = 0.11$ volt. If this plan be followed the amount of change of voltage from the beginning to the end of discharge will be practically equal at all rates, and the cell will be taken to a corresponding state of discharge each time.

Fig. 13 shows a series of tests made according to the above plan, and data figured therefrom. It will be seen that the ampere-hour output now decreases very slightly as the discharge rate is increased, but, as before, most of the loss is a voltage loss. The variation of ampere-hour output, average voltage, and watt-hour output with discharge rate is shown in Fig. 14, where normal values of these are each taken as 100 per cent.

## Specific Output.

In judging of the relative merits of storage batteries of different classes there are two appropriate bases of

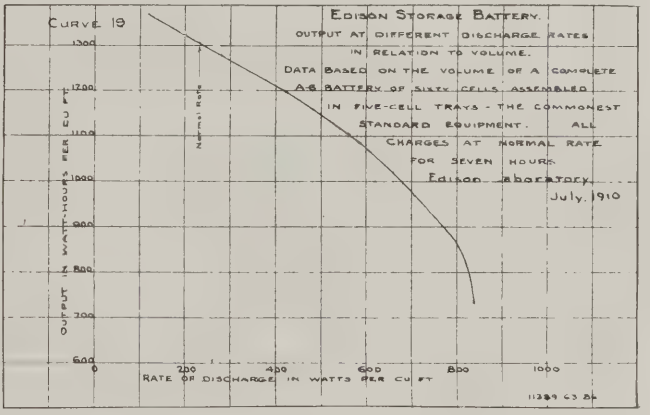

CURVE 19
EDISON STORAGE BATTERY.
OUTPUT AT DIFFERENT DISCHARGE RATES IN RELATION TO VOLUME.
DATA BASED ON THE VOLUME OF A COMPLETE A-6 BATTERY OF SIXTY CELLS ASSEMBLED IN FIVE-CELL TRAYS - THE COMMONEST STANDARD EQUIPMENT. ALL CHARGES AT NORMAL RATE FOR SEVEN HOURS.
Edison Laboratory.
July, 1910
Normal Rate
OUTPUT IN WATT-HOURS PER CU. FT.
RATE OF DISCHARGE IN WATTS PER CU. FT.

Fig. 16.—Relation Between Output and Volume.

comparison as to output—the basis of weight and the basis of volume. In all non-stationary service such as automobile or car propulsion, car-lighting and so forth, high output per unit-weight of battery is all-important, while the space which a battery occupies, if not ridiculously great, matters little, amounting to a question of vehicle design. In Fig. 15 is given the energy output at different rates of power delivery calculated for one pound of Edison battery; and the same referred to one cubic foot of battery is given in Fig. 16. The figures are based on the total weight and maximum volume—that is, the required volume of battery compartment—of a complete battery of a standard number of cells. These curves were derived from the normal-charge tests shown in Fig. 16. It is not the purpose of this paper to make comparisons, but those who have reliable data on lead batteries are invited to plot in comparative curves made on the same bases. They will then see that the Edison battery has an immense advantage in weight over the best lead batteries, while in volume it matches them pretty closely.

## Temperature.

The effects of changes of temperature on the behavior of a storage battery are so varied and numerous that a book could be written on this subject alone. Many tests of the Edison battery have been made to determine these effects and an extensive series of temperature tests is now being carried on at the Edison Laboratory; but the subject can merely be touched upon here, and later, in all probability, an entire paper will be devoted to it.

*(Concluded in the March Issue)*

# General News and Personal Mention

### CHICAGO ELECTRICAL SHOW.

The annual Chicago Electrical Show was held at the Coliseum Jan. 7-21. The feature of the show most noticeable was the increase in the exhibits of electric automobiles, and of storage batteries for use in them. As has been the case for several years past, exhibits of those applications of electricity appealing most to the public at large occupied most of the space. Household appliances, such as vacuum cleaners, toasters and chafing dishes, have to a large extent supplanted the heavy machinery.

Exhibits of interest to the railway electrical engineer were those of the Westinghouse Electric & Mfg. Co., General Electric Co., Edison Storage Battery Co., Electric Storage Battery Co., National Electric Lamp Association, and MacBeth-Evans Glass Co. Alba globes were used for the general illumination of the hall.

### GENERAL ELECTRIC BULLETINS.

Recently issued bulletins of the General Electric Company which will be of interest to the railway electrical engineer are:

No. B-3006. Luminous and Flame Arcs vs. Carbon Arcs.

No. 4602-B. Automatic Voltage Regulators for D. C. Generators.

No. 4685. Belt-Driven Alternators.

No. 4782. Direct-Current Exciter Panels.

No. 4785. Electric Drive in Woodworking Plants.

No. 4786. Signals, Auxiliary Apparatus and Materials.

No. 4798. Electric Railway Air Brake Equipments.

No. 4804. Direct-Connected Generating Sets.

No. 4807. Small Plant A. C. Switchboard Panels.

No. 4808. Washington, Baltimore & Annapolis 1200-Volt D. C. Railway.

No. 4809. 4500-Volt Oil-Break Switches.

No. 4810. Portable and Stationary Air Compressor Sets.

Any of these bulletins will be furnished upon request by the Publication Department.

### "PERMANIZED" NEGATIVE PLATES.

The Electric Storage Battery Company has just issued a bulletin on the "Permanized" Plante negative plate for car lighting service. The bulletin states that a serious defect in the Plante plate has been the solidifying and collapse of the spongy lead. As the capacity of the plate is directly proportional to porosity, this solidification seriously impairs the efficiency of the battery. "Permanization" is accomplished by the introduction in the spongy lead of finely divided, inert material. The bulletin gives tests showing the increase in capacity secured by this process of manufacture.

The directors of the Oliver Electric & Mfg. Co., of St. Louis, have declared a quarterly dividend of 1½ per cent, payable to stockholders of record Jan 1, 1911. At the annual meeting of the company, held Jan. 10, the old board of directors, consisting of F. W. Oliver, E. R. Hoyt and T. B. Entz, was re-elected. The treasurer's report, submitted to the stockholders, showed that the net gain in business during the past two years was approximately 100 per cent.

### REFILLABLE FUSE SHELLS.

The A. F. Daum Manufacturing Company, of Pittsburgh, is making a refillable fuse shell of very simple construction. The shell is made of a composition insulating material and is threaded at each end for the brass terminals, which are screwed on. Ordinary fuse wire is used, a coil being formed at each end after it is passed through the washer. Specially made fuses with copper terminals are also furnished if desired.

Daum Refillable Fuse Shell.

The advantage claimed for these fuse shells as compared with ordinary fuse plugs, is that they may be refilled any number of times, at practically no expense. Another advantage is that each shell can take either a 20 or a 30 ampere fuse. These fuse shells should be particularly useful in car lighting work where fuses often blow miles from the nearest source of supply.

The Western Electric Company has recently arranged to manufacture and sell booster telephone train dispatching circuits, the patents on which are owned by the Charter Electric Company. This system has recently received liberal adoption by the railways, over 30 per cent of all train dispatching telephones being so equipped.

The Harriman Lines have recently closed a standardization contract with the Willard Storage Battery Company, of Cleveland, Ohio, for their requirements of train lighting batteries. This contract was awarded to the Willard Company after a thorough service test of all makes of storage batteries extending over a period of two years.

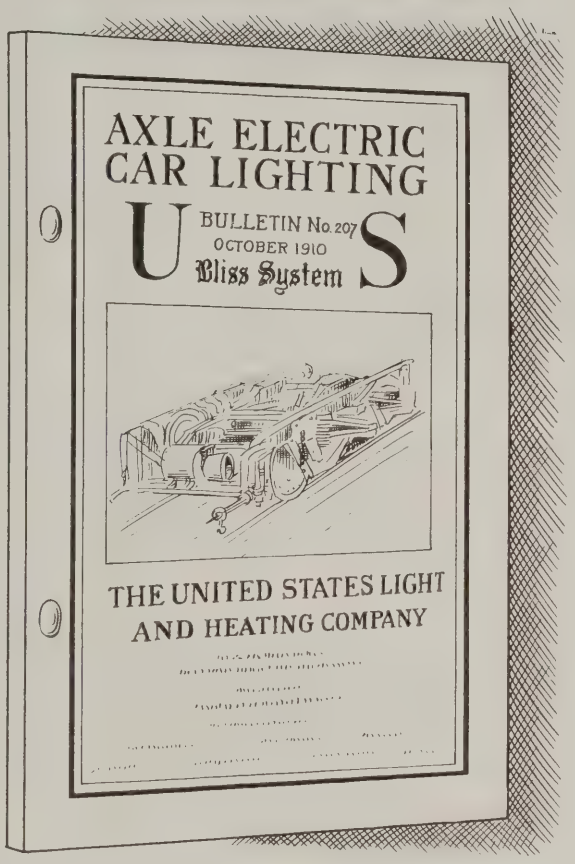
The Consolidated Railway Electric Lighting and Equipment Company announces the appointments of Thomas L. Mount as Eastern Sales Manager, and of L. J. Kennedy as Western Sales Manager. The New York office is in the Hanover Building and the Chcago office at 1720 Michigan Avenue.

Mr. Harold Kirschberg, formerly connected with the Pennsylvania Railroad, has taken the position of engineer for the Tipless Lamp Company, manufacturer of tungsten lamps for train lighting, and other purposes.

The Cutter Company announces the opening of an office at Detroit, Mich. Mr. C. E. Wise, formerly of the Chicago office, will look after I. T. E. interests in that vicinity. His address is 1418 Ford building.

E. W. Jansen, electrical engineer for the Illinois Central Railroad, has entirely recovered from a serious illness extending over a period of some weeks and is now back on the job regularly.

# JUST OUT!




## BULLETIN 207

Descriptive of **The Bliss System** of Electric Car Lighting. This System has met the conditions imposed by modern railroading with such eminent success that it has become the Standard with many Railroads and Car Builders. **Perfect Regulation, Lowest Operating Cost,** and **Absolute Reliability** are assured to the Purchaser.

*Write to our Railroad Department for Bulletin 207.*

**The United States Light and Heating Co.**

**General Office: 30 Church St., New York**

"Bliss System of Electric Car Lighting." "National" Batteries. "Moskowitz System of Electric Car Lighting."

NEW YORK BUFFALO CHICAGO CLEVELAND St. LOUIS BOSTON SAN FRANCISCO

### THE TRAIN LIGHTING BATTERY BUSINESS.

In a very short time the train lighting battery business has grown to be a very important part of the market for every battery manufacturer. In its annual review of the year's business in the first number of 1911, our contemporary, the *Electrical World*, says:

"The widespread movement toward electric train lighting has greatly increased the demand for batteries for this purpose, and the trade in railroad-car batteries during the past year has been probably larger than ever before in the history of train lighting."

In the same review a falling off in the number of batteries bought for power stations is noted. This is attributed to the increase in use of the steam turbine as a prime mover. It is sometimes cheaper to buy an additional turbine unit than to buy the storage battery equipment necessary to give the same additional capacity. Turbines also give better efficiency on variable loads than do reciprocating engines.

No trepidation need be felt by the battery manufacturers in contemplating this situation. The increase in the sales of train lighting batteries in 1911 over 1910 will probably be quite as great as was that of 1910 over 1909, and this condition will continue to prevail for some years to come.

### SANGAMO COMPANY EXPANDS.

Mr. M. B. Chase has resigned his position in the Detail and Supply Sales Department of the Westinghouse Elec. & Mfg. Co., Boston office, to accept the position of New York Manager for the Sangamo Elec. Co., of Springfield, Ill., who have opened offices in the Hudson Terminal Building, 50 Church St.

The increasing Eastern business of the Sangamo Co. has necessitated direct representation in New York, and the long experience of Mr. Chase in the design, manufacture and sale of meters especially fits him to take up the sale of Sangamo products which now embrace a complete line of A. C. and D. C. Integrating Watthour meters, Amperehour meters for stationary battery and vehicle work, Portable and Switchboard type Graphic recorders. A complete line of indicating instruments, both portable and switchboard forms, have been designed and will be offered for sale within a few months.

The New York office will be fully equipped from both an engineering and sales standpoint so that a large part of the work, especially that for devices to meet special conditions formerly referred to the Factory will be handled direct from New York.

A new factory is practically completed at Springfield which will enable the Sangamo Company to take care of their very rapid increasing business.

# Association Directory.

### ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....323 Kinzie St., Chicago.**

The next convention of the Association will be held in Washington, D. C., in the first week of June, 1911. The Annual Convention will be held in Chicago in the second week of November, 1911.

#### OFFICERS.

**President.**

J. R. SLOAN,
General Electrician, Pennsylvania Railroad, Altoona, Pa.

**First Vice-President.**

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Electrical Engineer, Santa Fe, Topeka, Kan.

**Second Vice-President.**

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H. C. Meloy, Chief Electrician, Lake Shore & Michigan Southern Ry., Cleveland, O.
F. E. Hutchinson, Chief Elect., C. R. & P. R. R., Chicago, Ill.
C. J. Causland, Chief Elec., Penna. R. R., Chicago, Ill.

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F. R. Frost, El. Engr., Santa Fe Ry.
A. J. Collett, Elec. Engr., U. P. R. R.
J. R. Sloan, Ch. Elec., Penna. Ry. Co.
C. R. Gilman, Ch. Elec., C. M. & St. P. Ry.
A. J. Farrelly, Elec. Engr., C. & N. W. R. R., Chicago, Ill.

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E. M. Cutting, Engr. Tr. Ltg., H. & V. Sou. Pac.
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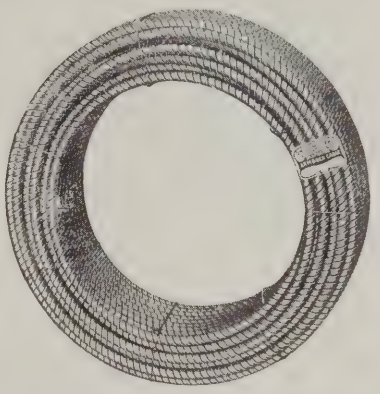

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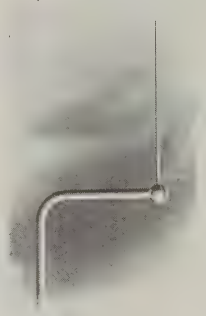

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used in the ordinary Tungsten lamps with NUMEROUS RIGIDLY fused Joints resulted in SHORT LIFE, HEAVY BREAKAGE, IRREGULAR SERVICE AND HIGH COST OF MAINTENANCE.

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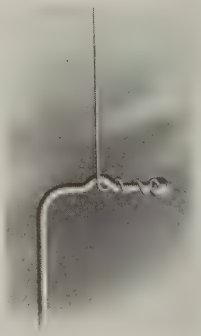

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## THE SALOM BATTERY is the greatest improvement in Storage Batteries in Thirty Years.

¶ By the Salom process the active material is formed and then applied under enormous pressures to the grid or contacting support. This method allows for all expansion and contraction of the active materials while they are being formed in bulk before it is placed into the grid. This method eliminates all the faults of the lead battery and results in much longer life and higher efficiency and voltage. The resistance between the active material and the grid is less than the Plante plate, due to the material being placed in such perfect contact with the supporting grid. This means higher voltage and better efficiency.

The positive plates cannot grow like the Plante plate because there is no further expansion of the active material and no lead to be converted into active material.

The negative plate cannot shrink, as there is no space left in the grid that is not filled with active material, and it cannot wash away because the Salom process produces a porus sheet of spongy lead and an antimonial lead grid for the support. The ideal condition that all battery manufacturers have strived for years to attain.

The antimonial lead is not acted upon by an electric current and the life of the plate is indefinite.

We can show you a saving in the maintenance of your present lighting equipment that will pay for the complete installation of the Salom Storage Batteries on your lines, giving you a larger factor of saving in your lighting equipments, reduce the force of operators in maintaining them and less expenditure for renewals than any other battery.

Send to Department G for a copy of the paper entitled, "Evolution of the Lead Storage Battery," read by Mr. Pedro G. Salom before the Electro Chemical Society of Chicago on October 14,1910. Instructive literature and complete details will be sent at your request by addressing us at one of the following offices:

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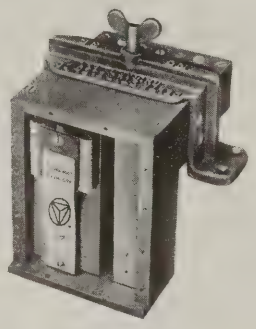
## Automatic Loop Switch



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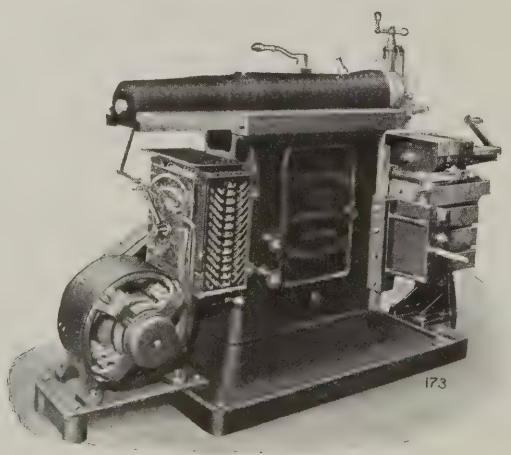
**are easily attached to machine tools or any other forms of machinery.**

**BEARING BRACKETS can be turned around for wall or ceiling operation without disturbing the electrical connections.**

**Are RELIABLE in every way.**



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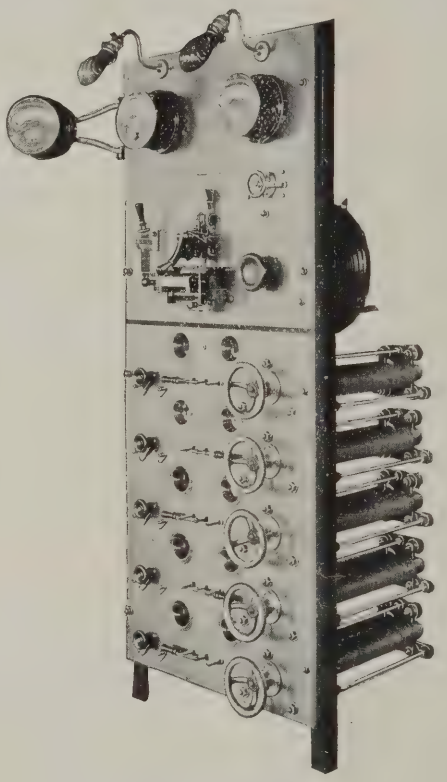

**Charging Switchboard for Railway Service**

## Mr. Railway Engineer—

If you want CONTINUOUS SERVICE in your charging plant together with CONSERVATION OF YOUR BATTERY and especially LOW COST OF INSTALLATION you can't afford to overlook the

**ALLEN-BRADLEY COMPRESSION RHEOSTAT**

Its wide range, close regulation and compactness give it a big advantage.

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**American Electric Fuse Co.**
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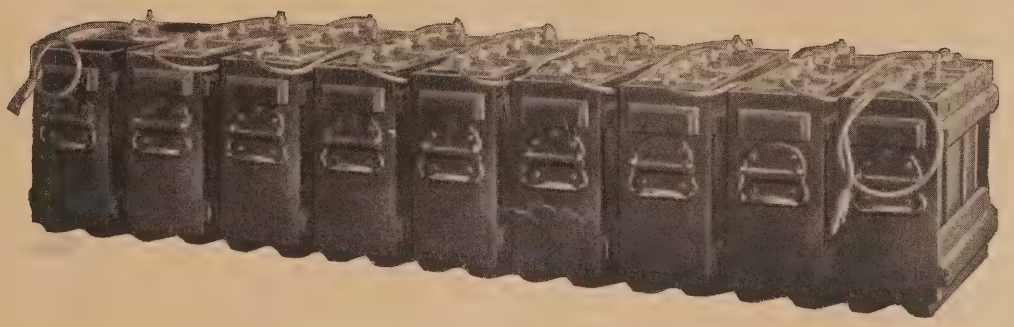
# The Edison Storage Battery for railway train lighting



Here is the 25-cell Edison equipment for 30 volts either straight storage or axle-generator lighting—it occupies 25 per cent less space under car body and weighs half as much as the 16-cell lead battery of equal capacity.

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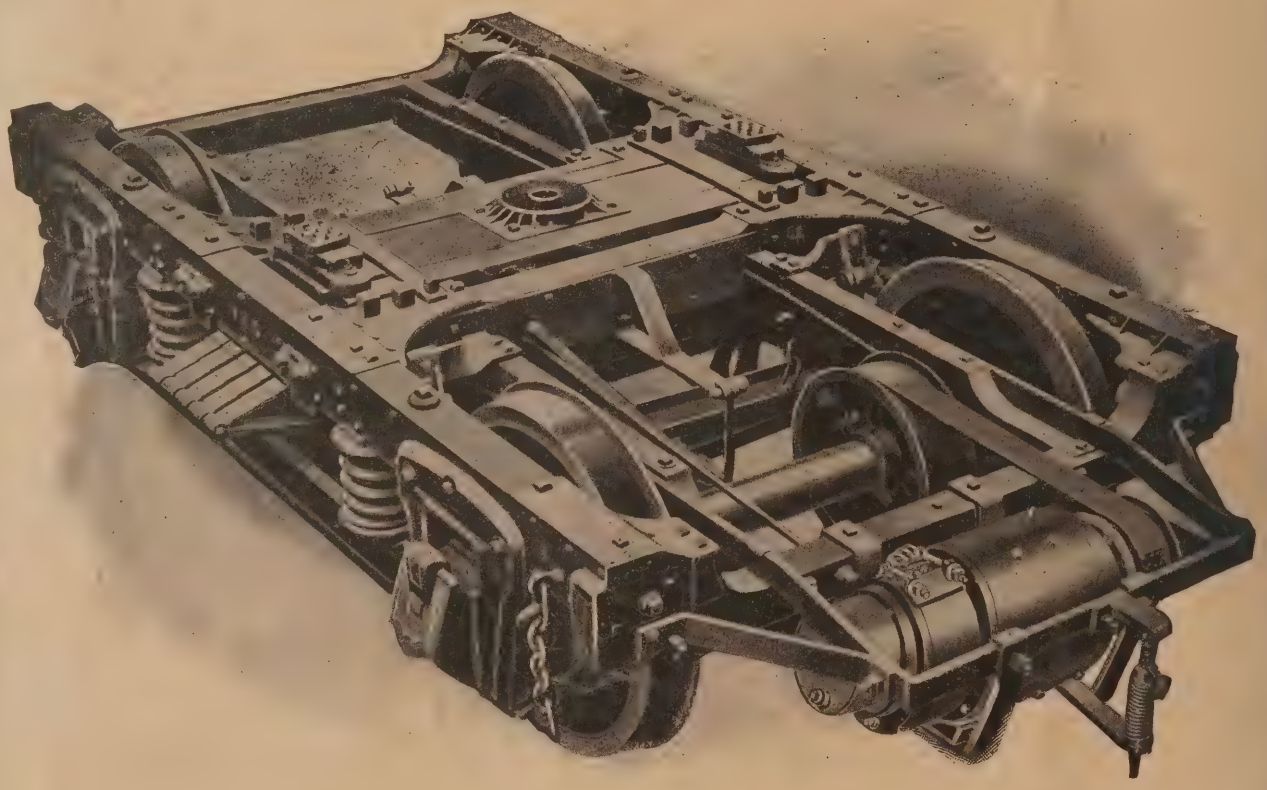
**EVERY EQUIPMENT GUARANTEED.**

**Regulating device for both Dynamo and Lamps concentrated in one machine**



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WITH WHICH IS INCORPORATED THE

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The Official Journal of the Association of Railway Electrical Engineers

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**The Heavy Core Plate which prevents Buckling.**
**Absolute Uniformity in the Active Portion of Plate.**
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# A Few Very Strong Arguments in re. The SALOM RAILWAY BATTERY--Not Fiction

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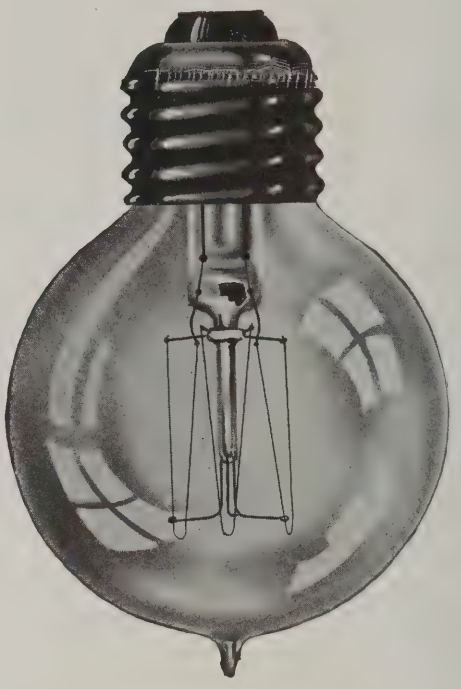
THE
# BUCKEYE
TRAIN LIGHTING
LAMP



embodies all the highest qualities to be found in any lamp. It is the result of a most careful study into the train lighting proposition and has been carefully designed to meet the special requirements of this service.

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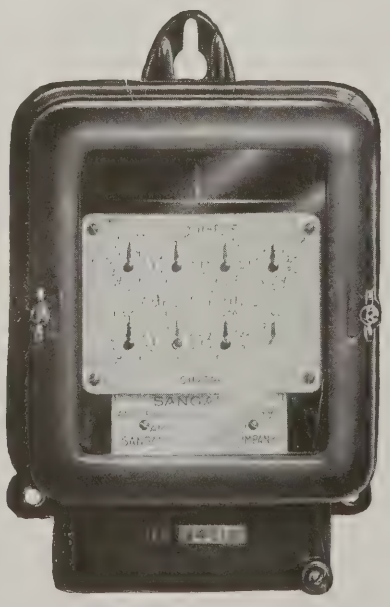
# Ampere Hour Meters for Storage Battery



## equipment will increase the life of the battery and provide an absolute check on the entire equipment

When applied to the operation of straight storage equipment the saving in current effected by the meter over that required when charging by the gravity method, will pay for the meter in three months.

In connection with Head End or Axle Lighting Equipment, the *Duplex Train Meter* provides an absolute check on the operation of the equipment, ensuring proper charging of the storage battery, and more reliable operation of the whole equipment. It will show you exactly how much the storage battery is being overcharged or undercharged.

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## SANGAMO ELECTRIC COMPANY
Springfield, Illinois

What you want from an electric lighting equipment is

# Light

You want light *in sufficient quantity* and *of proper quality.*

You want this light *when you want it* and *where you want it.*

You want this light supplied at a *minimum cost* of labor, material and depreciation.

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We are furnishing a *complete electric system* from the generator to the lamps.

We furnish a generator of *ample capacity for all the light you want.*

It is *ready when you want it.*

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The careful consideration of each and every component part and operation in its relation to the *efficiency of the system as a whole* is the foundation principle in the design and manufacture of our electric equipment.

This system is known as our *B. C. S.*

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*The generator* has the *latest improved suspension,* is *positively dust-proof, easily accessible* and has *ample capacity for all service.* The oiling device is positive, providing *ample lubrication,* the *pole changer is automatic* and simple and the armature is designed according to latest improved practice with form wound coils.

*Our dynamo regulator* is designed and *built to insure proper battery charge* by perfect control of the generator output. This control is accomplished by a carbon pile resistance in series with the dynamo field, and is varied by the action of a current and a voltage solenoid to *meet the varying conditions of speed and battery charge.* The constant normal rate of battery charge is lowered when approaching full charge and continues until the battery is *fully charged.*

The generator *cannot be overloaded* as the output does not exceed that for which the regulator is set; but the *maximum output is always available.*

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*The lamp regulator* keeps the *voltage constant on any number of lamps,* from one to the full number in your equipment, by a variable carbon resistance in series with the lamps.

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All necessary connections and resistance units are located on the *front of the regulator boards and easily accessible.*

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Our *one standard equipment meets all requirements* and with minimum attention gives efficient service. Used with our latest electric fixtures equipped with "Safety Shadeholders" and "Corona Shades" an ideal illumination for railroad cars is "at your service."

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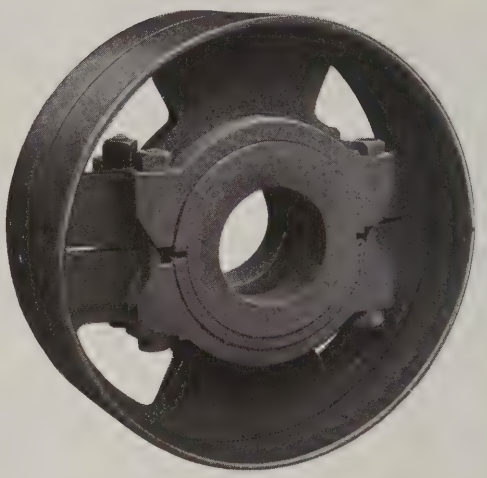
# The "AMERICAN" SPECIAL PULLEY



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While this pulley is made to meet the special demands of electric car lighting, its general principles are not different from the **World-famous** "American" Belt Pulley.

It has been pronounced by experts the best of its kind. This is but natural as it is the "first cousin" to the "American" Wrought Steel Pulley.

It is a parting pulley:—light, strong, easily put on or taken off, indestructible, accident proof.

Write for more explicit information. We will cheerfully send you our complete catalog showing the full line of our standard belt pulleys. Made in sizes 6 inch to 60 inch diameter: 2 inch to 36 inch face. Also made in sizes intermediate to those listed.

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This battery plate, among all the various forms of Plante type of plate construction, has the unique distinction, of possessing the greatest mechanical strength. This feature of superiority in the "Tudor" positive plate, particularly adapts it to car lighting service. The following are the features of superiority in this plate.

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2. **The distinctive feature of through and through circulation of electrolyte.**
3. **Re-inforced features made possibe by its type of construction.**
4. **A large amount of reserve lead in the ribs.**
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Railway electrical engineers will appreciate that these features of the "Tudor" positive plate are such as will give long life.

**The "Tudor" Positive Plate**

Engineers interested in car lighting will find "Catalog C," a copy of which can be procured from any of the Sales Offices, to contain useful information

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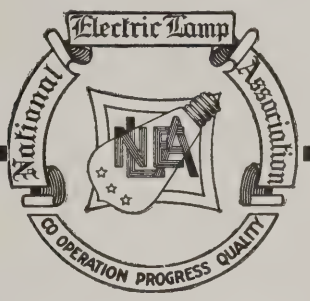


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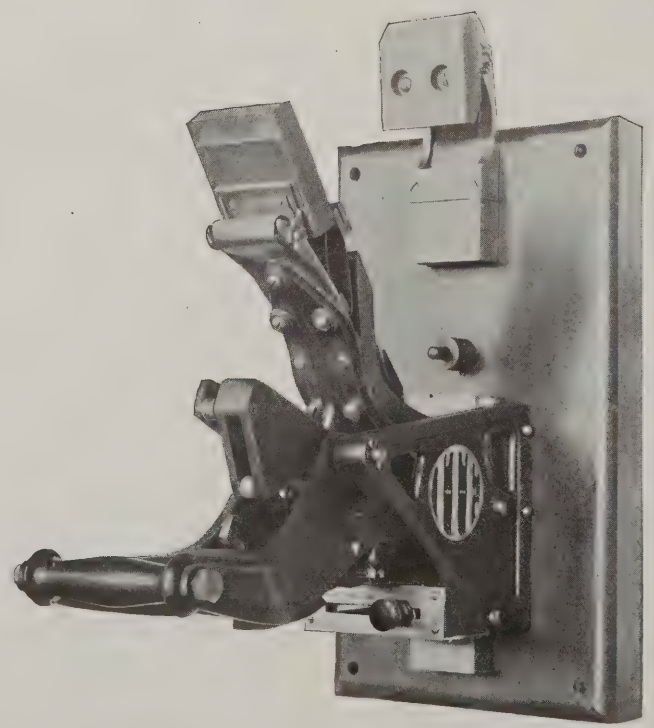

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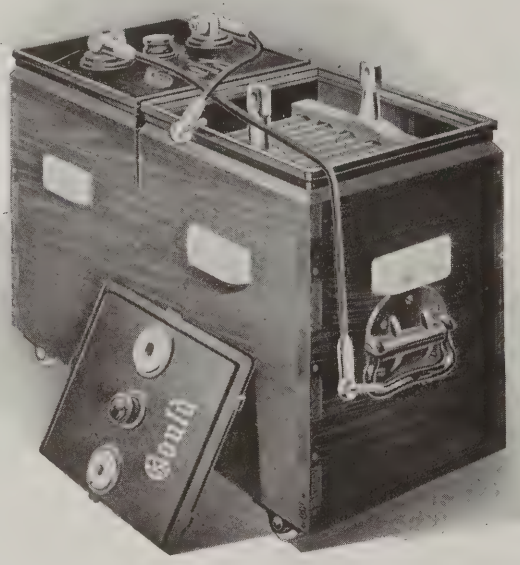


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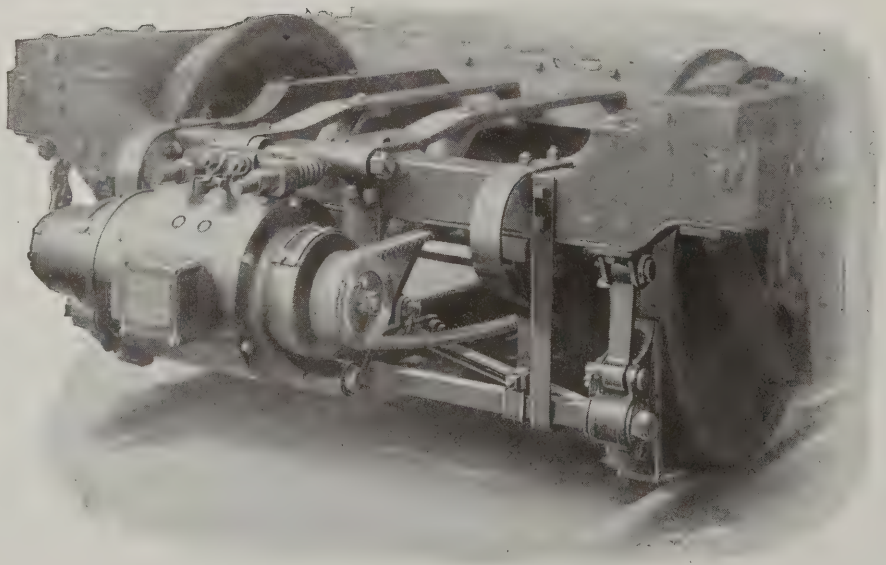

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# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

**WRAY PUBLISHING CO.**

EDWARD WRAY, President. J. G. WRAY, Sec. & Treas.

RALPH BIRCHARD, Manager.

92 LA SALLE ST. CHICAGO

Telephone Main 2457.

Editors ..... Edward Wray, C. L. de Muralt, Geo. W. Cravens, Ralph Birchard

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

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TERMS OF SUBSCRIPTION

United States, Canada and Mexico . . . Per Year, $1.00


**OUR OBJECT.**

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


EDITORIALS—
- Smoke ..... 205
- The Decision ..... 205
- The Railway Appliances Show ..... 205

Association News ..... 206
Car Lighting Club ..... 206
Electric Lighting in Railway Cars ..... 207
Lamp Specifications Conference ..... 207
Locomotive Smoke in Chicago ..... 208

ELECTRIC TRACTION SECTION—
- Modern Tendencies in Electric Locomotive Design ... 211
- Pennsylvania Orders Electric Locomotives ..... 213
- German Results with Storage Battery Cars ..... 214
- Electrification of Congo Railway ..... 214
- New York Central's Electric Extension ..... 215
- Hoosac Tunnel Electrification ..... 215
- The Tide Continues to Turn ..... 215

SHOP SECTION—
- Variable Speed Induction Motors ..... 216
- The New Haven Shops at Readville ..... 217

The 1910 Edison Storage Battery ..... 219
Electrical Train Equipment in South Africa ..... 220
The Dope Sheet ..... 221
General News and Personal Mention ..... 222
U. S. Light & Heating Company's New Regulator ..... 14
Association Directory ..... 14


### Smoke.

TO the small town smoke is something to welcome and be proud of. A dark band of soot trailing off into the horizon is the glorious badge of industry. Every time a cinder rolls down the neck of the prominent citizen he is reminded that this is the age of steam and of machinery and that Podunk is marching in the vanguard of progress. The big town takes a different view of smoke. Pittsburg and Chicago darken the sky for miles around. They do a good deal of manufacturing and merchandising but New York does twice as much with half the smoke. So it becomes obvious that a city's prosperity is not necessarily in direct proportion to the density of its atmosphere. Smoke is no longer a distinction; it is a nuisance not to say a disgrace.

The smoky age of steam was and is a wonderful age, but the smokeless age of electricity, upon which the world is just entering, is and will be vastly more wonderful.

Offhand it would seem that the problem of measuring a city's smoke and determining whence it came and why would be about as hard a problem as could be found. It has been done in Chicago, not, perhaps, with the exact accuracy which it is possible for a chemical analysis to attain, but with sufficient exactness to arrive at the following very definite conclusions:

1. Although the locomotives of the city use only 18½ per cent of the total coal, they make 43 per cent of the total smoke and over one-half of the total dirt.
2. According to the Ringlemann system of judging the density or blackness of smoke, the average density of locomotive smoke in Chicago is 23 per cent.
3. Approximately 10 per cent of all coal fired in a locomotive firebox is discharged from the stack in the form of cinders. Within the city of Chicago about 560 tons (14 carloads) of cinders from locomotive smokestacks are dropped every day.
4. Electrification offers the only final and satisfactory solution of the smoke problem.

The methods by which these conclusions were reached are detailed in another part of this issue. It is possible that some may question them. But it is hard to see how any man could reach conclusions much different, whatever his methods.

This investigation, which was conducted by a city officer by, for, and at the expense of the city, will no doubt have its effect upon the council in its action on the mandatory ordinance compelling the railroads to electrify which is now pending. It should have an effect. It was instituted for that purpose. And if we accept the findings we cannot help but agree that no time should be lost in taking steps toward railroad terminal electrification which will in a large measure do away with city smoke.

### The Decision.

THE Interstate Commerce Commission in its infinite wisdom has decided that no advance in freight rates is justified. This news is not exactly welcome to the many thousands all over the country who have given their time and energy to the advancement of railway practice, and who dislike to see the fruits of their labor cast aside because the capital for improvements is not to be had. But there is no disposition to say that the Commission did other than what it honestly believed to be the square, just and equitable thing. The only regret is that its powers and duties might not be extended to increase efficiencies somewhat along other lines so that it need not, as set forth by Mr. Will Payne in the *Saturday Evening Post*, cost more to deliver a pound of meat from the retail market to the ultimate consumer than it does to transport that same pound of meat from Texas to Kansas, from Kansas to Chicago, and from Chicago to the retail dealer in New York or New England.

### The Railway Appliances Show.

EVERY so often the voice of the pessimist is heard in the land saying that the exhibit business is being overdone, and that enterprises such as the Railway Appliances Show do no real good and cost a lot of

money. The same opinion has been expressed in regard to advertising from time out of mind. More advertising is done every year and each show is larger than the one before. It is axiomatic that only fit things survive. Therefore, since the Railway Appliances show survives, it must be of use. Really this use is not very hard to perceive. It presents a concentration of the latest developments in railway materials. The man interested can see there in one day what it would take him months to see if he had to make a pilgrimage to the places of manufacture. To anyone who can comprehend this fact it is easy to understand why the Railway Appliances Show must go each year with greater and greater success.

## ASSOCIATION NEWS.

**This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.**

**It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.**

### SEMI-ANNUAL CONVENTION.

The dates for the semi-annual convention of the Association at Washington, D. C., have been fixed as June 15 and 16. The Master Car Builders' Association will meet at Atlantic City June 19-21. Members desiring to do so will therefor be able to attend both conventions.

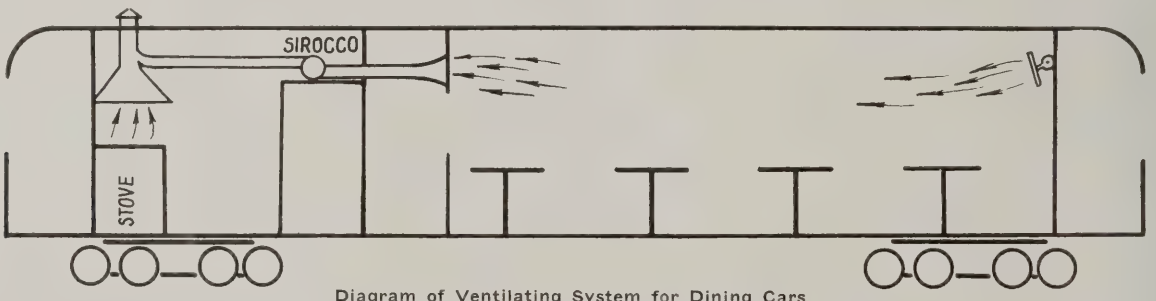



Diagram of Ventilating System for Dining Cars.

### ANNUAL CONVENTION ARRANGEMENTS COMMITTEE.

A joint committee on arrangements for the annual convention next fall has been appointed. It consists of Jos. Andreucetti and F. E. Hutchinson, from the Association of Railway Electrical Engineers, and W. E. Ballentine and G. H. Atkins, from the Association of Railway Electrical Supply Manufacturers.

### VOLUME III OF PROCEEDINGS ISSUED.

The secretary has recently sent out copies of Volume III of the Proceedings for 1910 to all members of the Association who have paid their 1911 dues. Any member who has not received his copy should communicate with the secretary.

## CAR LIGHTING CLUB.

The Car Lighting Club met Wednesday, February 1st, at the Chicago Press Club. The subject for the evening was car ventilation. The principal speakers were H. H. Smith, western sales manager for the Diehl Electric Company, and B. W. Stowe, engineer for the Adams-Bagnall Company.

Mr. Smith said that the ordinary "buzz" fan had been found inadequate for actual car ventilation. This fan is efficient only where it is placed in free air. If the flow of air from or to the fan is restricted by flues of any sort, the fan performs very little useful work. For this reason a positive draft blower is superior in many cases. The type of blower which goes under the name "Sirocco" was recommended.

A fan of this type having an intake opening of 7 inches with a 6-inch outlet, direct-connected to a motor having an output of about 1/5 h. p. and a speed, with unrestricted intake, of about 2,600 r. p. m., affords the best possible combination from the standpoint of efficiency, dimensions, capacity and cost. This fan has a capacity of approximately 3,600 cu. ft. per minute and delivers air under a positive pressure of about ½ ounce.

This type of fan is installed in a dining car of one of the prominent eastern lines. In this case a round duct about 8 inches in diameter is brought from an ornamental grill, or screen, over the arch at the kitchen end of the dining compartment into and through the kitchen, terminating in the hood over the range at the point where the slope of the hood joins the chimney leading through the roof. On top of the pantry a Sirocco type fan is connected into the duct in such a way that the intake is from the dining compartment and the exhaust into the hood. At the intake end the duct is funnel-shaped for the space of a foot or more, the opening in the grill being about 12 inches in diameter. Two 12-inch ordinary fans placed at the opposite end of the dining compartment keep the air moving toward the exhaust duct. The draft induced in the chimney carries away the smoke from the range, and none of this smoke and grease comes into contact with the fan.

Mr. Stowe described a proposed system of car ventilation in which the exhaust will be through openings in the deck sash. He said that the "vane" type of fan appeared to be better adapted to the purpose than the Sirocco type. It can produce a positive draft at considerably lower speed. He said that the question of whether it is better to use a pressure system, which forces pure air in, or a vacuum system, which forces vitiated air out, has not yet been decided. Neither has the question of whether it is best to introduce pure air near the floor or near the ceiling. Authorities can be cited to prove the superiority of either method.

Although at present the ventilation of dining cars is the most pressing problem, there is little doubt that within a few years the public will demand equal care in the ventilation of all railway cars. The feature of dining car ventilation which makes it so difficult is the greasy smoke which comes from the broilers. Whether an induced draft such as that described by Mr. Smith will take care of this smoke, and remove it, seems questionable. Probably a direct exhaust blower placed in the roof would be necessary.

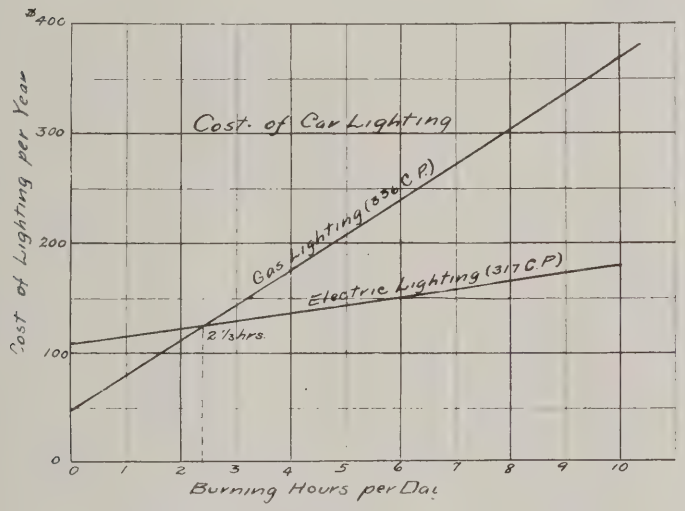
Other points in connection with car ventilation were brought out by Messrs. Frost, Cravens, Everett, Myers, Farelly and Birchard.

Following the business session there was a brief discussion of ways and means for popularizing the club and getting a larger attendance at its meetings. It was decided to hold the next meeting on the third Wednesday of the month instead of the first Wednesday, as heretofore. This will bring the next meeting of the club on March 15. Other arrangements are the same as previously.

## ELECTRIC LIGHTING IN RAILWAY CARS.*

Leitner emphasizes, in consideration of the railway catastrophies occurring recently which were connected with conflagrations, the necessity of introducing electrical illumination into railway cars. Electric train lighting is absolutely safe from fire, and no less favorable than gas lighting in regard to the pure costs of operating. One can estimate the number of cars at present lighted by electricity in Europe and America together at about 40,000.

With a calculation of the comparative costs of operation, the costs of power required, which are very low, can remain considered, since these costs are about equal for both methods of lighting in consideration of




Comparative Cost of Electric and Gas Car Lighting.

the great weight of the gas lighting equipment. Under the assumption that it deals with a car in which 22 16-candlepower metal filament lamps are installed, and which during 24 hours moves with an average velocity of 30 miles an hour, it gives the cost of operation as 0.21 cents for the 16 candle lamp-hour, or .013 cents per candlepower-hour. In these costs of operation are considered the costs for lamp renewals, the upkeep and attention. The costs for interest and depreciation amount to 0.16 cents per candlepower-hour, and the total operating costs amount to about 0.37 cents, or 0.023 cents per candlepower-hour. The lighting cost per car per year, with an assumed daily burning of 5 hours, thus stands at about $150.

In a comparison with gas lighting it is most suitable to find what costs would be caused by the lighting equipments if it were not used. With the electric lighting of the above described car, there resulted a fixed cost of about $107. with a mixed gas lighting this fixed sum amounted to about $41, according to Wichert. To this fixed amount there must be added: with electric lighting the lamp renewals, lubricants and carbon brushes; with gas lighting, the cost of gas consumed; and with both kinds of lighting, the cost of maintenance equipment, attention, etc. For electric lighting these costs amount to about $9 for every daily burning hour during a year, and for gas lighting $34, according to Wichert. If these figures are plotted into a curve (Abb 29), it results that the electric lighting comes to be more expensive at a very small demand on it than gas lighting, but that the cost of gas lighting far exceeds it at anything over about 2 burning hours per day. For gas lighting there is assumed a total candlepower of 374 and a gas price of about 15 cents per cubic meter. With the use of mantles gas lighting might be more economical, but there are no authentic figures at hand for this. But even at approximately equal operating costs it would be the duty of the controlling corporations to introduce the considerably less dangerous electric lighting. Finally, from the railway technical point of view, electric train lighting has the advantage of making the cars freely detachable, a property which cannot be imparted to them with gas lighting.

*Translated from Electrotechnische Zeitschrift.

## LAMP SPECIFICATIONS CONFERENCE.

The United States Government, through the Department of Commerce and Labor, Bureau of Standards, has issued a call for a conference for the purpose of revising the Government Specifications for Incandescent Lamps.

Invitations to attend this conference have been issued to the various lamp companies and a number of interests representing the large purchasers of lamps.

On account of limited facilities and the desire to not have an attendance so large as to be hampered by lack of facilities, and for the reason that the Pennsylvania Railroad Company is the largest purchaser of lamps among the railroads of the United States, and has done considerable work on the methods of testing incandescent lamps, the Pennsylvania Railroad Company was the only railroad company invited to attend this conference.

In extending the invitation to the Pennsylvania Railroad Company, however, it was understood that they would officially represent the railroad interests as a whole, and arrangements have been made whereby the representatives of the P. R. R. will also directly represent several of the other prominent roads east of Chicago, and one of these gentlemen will be the official representative of the Association of Railway Electrical Engineers.

A meeting was held in Altoona, Pa., on February 9, 1911, at which were present representatives of the various roads as above, and also of the Association of Railway Electrical Engineers, to discuss the proposed revision of the specifications and obtain an expression of opinion as to what changes, if any, should be made.

The representative of the Association of Railway Electrical Engineers has made request on the officials of the various roads whose employees are members of the association for data covering their purchases of lamps during the year of 1910. It is hoped that the information desired will be forwarded promptly so as to be in the hands of the representative before the date of the conference called by the Government, the date for which has not been set, but, it is understood, will be some time in the near future.

# Locomotive Smoke in Chicago*

By PAUL P. BIRD

Chicago is the greatest railroad center and one of the largest manufacturing centers in the world. Soft coal from Illinois and Indiana is the universal fuel used to carry on this industrial activity, but as this coal is difficult to burn without making smoke, the result has been to defile the atmosphere with great quantities of smoke and dirt. To reduce this condition to a minimum is one of the problems confronting the engineers of Chicago. Although this same situation is found in all of the larger cities of the middle west, it is Chicago that is leading and must continue to lead in the intelligent fight against the smoke nuisance.

For years it has been an open question as to how much of the total smoke of Chicago is made by railroad locomotives. It is often stated by railroad officials that the railroads make a very small proportion of the total smoke, and that from a standpoint of smoke prevention the electrification of railway terminals is unwarranted. During the last few months the department of smoke inspection of the city of Chicago has made an investigation to determine the proportion of the total smoke made by the railroads, and it is the purpose of this paper to describe this investigation.

### Conclusions Reached.

The results of this study may be summarized as follows:

1. Although the locomotives of the city use only 18½ per cent of the total coal, they make 43 per cent of the total smoke and over one-half of the total dirt.

2. The locomotives consume, within the city limits, 5,600 tons of soft coal daily, or about 1,850,000 tons annually.

3. According to the Ringlemann system of judging the density of blackness of smoke, the average density of locomotive smoke in Chicago is 23 per cent.

4. Railroad locomotives make 43 per cent of all the smoke made in Chicago.

5. Because smoke from locomotives carries with it large quantities of sparks and cinders, such smoke is a greater dirt producer than smoke from stationary plants.

6. Although locomotives make 43 per cent of the total smoke, because of the character of the smoke they produce over one-half of the total dirt traceable to smoke.

7. The lowest average density of smoke produced by any one road is about 10 per cent. This figure probably represents as low an average as can be maintained with steam locomotives, using soft coal.

8. If all locomotives in Chicago maintained an average smoke density as low as 10 per cent, the locomotive smoke woud still form 29 per cent of the total smoke and probably produce over one-third of the dirt.

9. Locomotives in the neighboring towns outside of Chicago make an average smoke density of about 41 per cent, showing that the anti-smoke campaign in the city has already reduced the smoke nearly one-half.

10. Approximately 10 per cent of all coal fired in a locomotive firebox is discharged from the stack in a form of cinders. Within the city limits of Chicago about 560 tons (14 carloads) of cinders from locomotive smokestacks are dropped every day.

11. There are about 2,200 miles of railway track in the city limits. At all times there are about 1,400 different locomotives working in the city, and during a week as many as 3,740 different locomotives are in Chicago.

### Coal Consumption.

As smoke is caused chiefly by the incomplete combustion of bituminous coal, the basis of this investigation is a study of the coal consumption of the city.

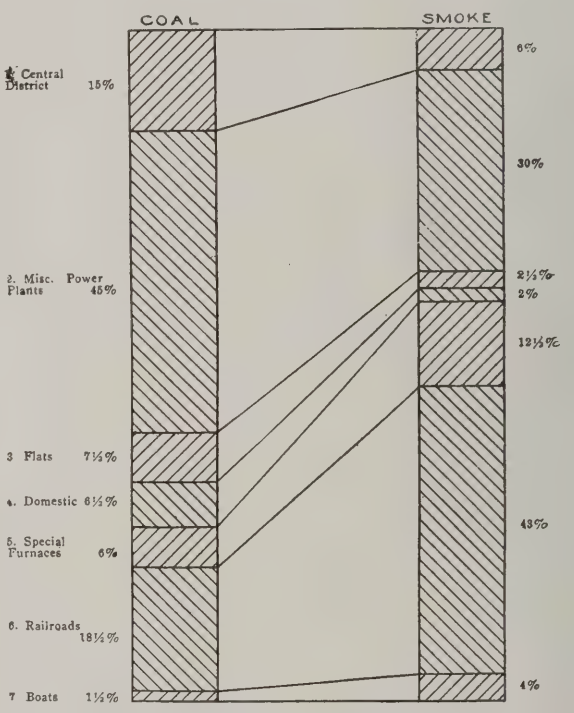



**Diagram Showing Percentages of Total Coal and Total Smoke in Chicago.**

The smoke department has gotten together as much information on this subject as possible, and gives as its opinion that there are burned in the city limits of Chicago annually 10,000,000 tons (2,000 lbs. each) of bituminous coal. This figure may be taken for the year 1910 and to include semi-bituminous or Pocahontas coal. From 1893 to 1906 a record was kept of all coal shipped into Chicago and all coal shipped away. This record showed that in 1906 the consumption was about 8,000,000 tons. A curve drawn through the points obtained by plotting this record for the thirteen years between 1893 and 1906 shows that a gain of 2,000,000 tons from 1906 to 1910 is consistent and probable. A check on this total figure of 10,000,000 tons has been obtained by accounting for its use amongst the different consumers of soft coal.

The coal used by the railroad locomotives has been accurately estimated. The smoke department wrote to all the railroad companies and asked for estimates of coal burned by locomotives in the city limits. The returns show a total of 5,601 tons.

*Abstract of a paper by Paul P. Bird, chief smoke inspector for the city of Chicago, before the Western Society of Engineers, February 15, 1911.

**Method of Determining Density.**

The Ringlemann method of determining the density of smoke makes use of a number of white sheets crossed with black lines in appearance like the wires of a screen. The black covers 0, 20, 40, 60, 80 and 100 per cent of the sheets. When placed some distance from the observer they appear various shades of gray. The observations are made by comparing the shade of the smoke with the screens, and estimating the density.

An important part of this investigation of the density of smoke in Chicago has been a study of the smoke made by railroad locomotives. During October and November, 1910, a special observer spent his entire time on the rights of way of the railroads in the city limits. During these two months he made over 11,000 separate observations and watched the locomotives of thirty different railroad companies. The observer was assigned each day to a certain point on the right of way of some road, often at a junction of two or more roads, his instructions being to watch every locomotive coming within his sight, and to record in his memorandum book the number of minutes during which he watched the engine and his estimate of the density of the smoke in accordance with the Ringlemann charts. It is probably unnecessary to say that this work was done with absolute impartiality and that no effort was made to watch the engines of one road more than another.

In Table No. 1 is shown the list of all the railroads whose locomotives were observed during this investigation. They are arranged according to the average density of smoke, the road having the lowest average being first on the list. Locomotives of 30 different roads were observed, but in four cases less than 50 observations were made; therefore these are not listed with the others, because it is felt that not enough observations were made to arrive at a proper average. This list shows the locomotives of the Wisconsin Central Ry. (leased by the Mnneapolis, St. Paul & Sault Ste. Marie) as occupying first place with an average density of smoke of 10.76 per cent. The Chicago Junction Ry. occupies the lowest position in the list with an average of nearly 42 per cent. The average percentage of locomotive smoke density in the two months' investigation is 22.3 per cent.

TABLE I.

Average Density of Smoke from Locomotives.
(Within City Limits of Chicago.)
October and November, 1910.

| | October-November Total | Observations. | Percentage of Density. | Observations. | Percentage of Density. | Observations. | Percentage of Density. |
|---|---|---|---|---|---|---|---|
| No. | Railroad— | | | | | | |
| 1 | Wisconsin Central Ry | 30 | 19.6 | 72 | 9.8 | 102 | 10.76 |
| 2 | L. S. & M. S. Ry | 116 | 19.5 | 564 | 13.88 | 680 | 14.43 |
| 3 | Illinois Central R. R | 490 | 12.39 | 877 | 15.20 | 1.367 | 14.50 |
| 4 | A., T. & S. F. Ry | 50 | 20.8 | 40 | 8.6 | 90 | 15.42 |
| 5 | Michigan Central R. R | 127 | 15.44 | 160 | 17.8 | 287 | 16.92 |
| 6 | Pere Marquette R. R | 17 | 33.33 | 109 | 16.95 | 126 | 18.01 |
| 7 | Wabash R. R | 69 | 28. | 98 | 15.4 | 167 | 19.94 |
| 8 | N. Y., C. & St. L. R. R | 118 | 24.54 | 52 | 14.48 | 170 | 20.95 |
| 9 | C., M. & St. P. Ry | 771 | 19.4 | 469 | 21.9 | 1,240 | 21. |
| 10 | C. I. & L. Ry | 39 | 31.87 | 29 | 13.33 | 68 | 21.35 |
| 11 | C. & E. I. R. R | 38 | 25.27 | 69 | 20. | 107 | 21.9 |
| 12 | Pennsylvania R. R | 643 | 23.6 | 449 | 21.65 | 1,092 | 22.6 |
| 13 | Erie R. R | 64 | 28.45 | 35 | 16.34 | 99 | 23.61 |
| 14 | B. & O. R. R | 102 | 20.58 | 294 | 24.34 | 396 | 24.01 |
| 15 | C. & N. W. Ry | 632 | 23.07 | 752 | 24.94 | 1,384 | 24.07 |
| 16 | C. I. & S. R. R | 22 | 28. | 47 | 22.7 | 69 | 24.09 |
| 17 | C., B. & Q. R. R | 363 | 26.5 | 626 | 22.97 | 989 | 24.16 |
| 18 | C., R. I. & P. Ry | 110 | 29.78 | 454 | 25.46 | 564 | 25.96 |
| 19 | Belt Ry. | 96 | 33.2 | 351 | 23.88 | 447 | 26.02 |
| 20 | C. G. W. R. R. | 52 | 26.6 | 191 | 26.41 | 243 | 26.43 |
| 21 | C. & A. R. R | 113 | 25.8 | 90 | 33.56 | 203 | 28.52 |
| 22 | Ill. Northern Ry | 61 | 31.06 | 10 | 17.14 | 71 | 29.35 |
| 23 | C. T. T. R. R | 114 | 29.41 | 289 | 29.69 | 403 | 29.57 |
| 24 | C. & W. I. R. R | 38 | 36.1 | 19 | 17.77 | 57 | 30.26 |
| 25 | Grand Trunk Ry | 101 | 36.7 | 209 | 31.6 | 310 | 32.38 |
| 26 | Chicago Junction Ry | 298 | 42.9 | 28 | 28.66 | 326 | 41.78 |
| | Roads having less than 50 observations— | | | | | | |
| 1 | C. & O. R. R | 1 | 80. | 6 | 7.5 | 7 | 8.61 |
| 2 | E., J. & E. (and C., I. S. & E.) Ry | 3 | 36.66 | .... | .... | 3 | 36.66 |
| 3 | Chicago River & Ind. R. R | 35 | 55. | .... | .... | 35 | 55. |
| 4 | Manufacturer's Junction Ry. | .... | .... | 1 | 60. | 1 | 60. |
| | Total | 4,713 | 24.27 | 6,390 | 21.17 | 11,103 | 22.30 |

During the month of December, 1910, the same observer who had worked in Chicago on the investigation of railroad smoke was sent to eight different towns outside the city limits to make similar observations. Table 2 shows the results obtained. In this table the railroads are listed according to the density of smoke—the one averaging lowest being first. In these eight towns the density of smoke averaged 41 per cent. This is probably a fair figure for the performance of a locomotive using Illinois or Indiana coal with no particular attention paid to preventing smoke. Table 6 gives these results listed according to the towns visited. Streator, Ill., had the smokiest locomotives, 361 observations averaging 51 per cent smoke density. This indicates the results of the anti-smoke campaign in Chicago. It shows that outside of the city, where no effort is made to prevent it, the smoke is nearly twice as dense as in Chicago. This is true of

the stationary plants as well as the railroads. If the citizens of Chicago will compare their city with all other cities in the middle west they will find that, plant for plant, locomotive for locomotive, chimney for chimney, Chicago is the cleanest of all.

### Character of Locomotive Smoke.

Locomotive smoke carries with it quantities of sparks and cinders, while in stationary plants relatively little of such material is thrown out. This is because of inherent features in the grate design that are unavoidable. On a locomotive there is so little room available that the grate surface of the boiler is necessarily small and there is consequently required a powerful draft for burning enough coal to do the required work. This draft is obtained by discharging the exhaust steam from the engine cylinders up the stack. Because of this strong draft there is drawn out of the firebox with the smoke great quantities of fine coal and ash, which in turn are discharged from the stack in the form of cinders. It is a recognized fact amongst railway men that from 8 to 18 per cent of all bituminous coal put into locomotive fire boxes escapes from the stack in this manner. In Chicago about 5,600 tons of coal are burned in locomotives each day. Assuming that 10 per cent of the coal leaves the stack in the form of cinders, it means that 560 tons of cinders are thrown into the air and dropped on the city of Chicago every day. This is equal to about 14 carloads. On the other hand, in stationary plants where there is plenty of room for a larger grate surface and where the coal is burned with a lower draft and with tall chimneys, but few cinders are carried out with the smoke. Therefore the smoke from locomotives on account of carrying with it sparks and cinders is far more objectionable than the smoke from stationary plants, and as it is discharged into the atmosphere at no great distance from the ground and is trailed over long courses, it is safe to say that from the standpoint of a nuisance the steam locomotive is the worst offender of all. The investigation already described shows that the locomotives of Chicago make about 43 per cent of the total smoke. Considering its character, the conclusion seems warranted that steam locomotives produce over one-half of the dirt traceable to smoke.

TABLE II.

Average Density of Smoke from Locomotives.
Out of Town Observations—Listed According to Railroads.

| No. | Railroad— | Observations. | Percentage of Smoke Density. |
|---|---|---|---|
| 1 | L. S. & M. S. Ry. | 7 | 17.14 |
| 2 | Pere Marquette R. R. | 14 | 30.77 |
| 3 | C., M. & St. P. Ry. | 494 | 31.07 |
| 4 | C. & N. W. Ry. | 229 | 31.2 |
| 5 | C., B. & Q. R. R. | 618 | 36.97 |
| 6 | Grand Trunk Ry. | 40 | 40.0 |
| 7 | Indiana Harbor Belt R. R. | 35 | 40.54 |
| 8 | Illinois Central R. R. | 429 | 42.48 |
| 9 | C. T. T. R. R. | 14 | 43.53 |
| 10 | Michigan Central R. R. | 117 | 43.75 |
| 11 | C., R. I. & P. Ry. | 253 | 44.38 |
| 12 | Erie R. R. | 71 | 47.66 |
| 13 | C. & O. R. R. (of Indiana) | 8 | 48.0 |
| 14 | C. I. & S. R. | 325 | 48.53 |
| 15 | C. & A. R. R. | 196 | 49.36 |
| 16 | C. I. & L. Ry. | 53 | 50.0 |
| 17 | A., T. & S. F. Ry. | 241 | 50.02 |
| 18 | E., J. & E. (and C., L. S. & E.) Ry. | 57 | 50.98 |
| 19 | N. Y., C. & St. L. R. R. | 34 | 52.56 |
| 20 | Wabash R. R. | 31 | 54.40 |
| 21 | C., C., C. & St. L. Ry. | 87 | 54.51 |
| 22 | B. & O. R. R. | 11 | 61.90 |
| 23 | Pennsylvania R. R. | 2 | 80.0 |
| | Total | 3,366 | 41.1 |

### Smoke Prevention Possibilities.

The accompanying table shows that the lowest percentage of smoke density made by the locomotives of any railroad was 10.7 per cent. Probably 10 per cent is as low an average as can be maintained with steam locomotives using soft coal. Therefore the very best condition that can be hoped for in Chicago is to have all locomotives average 10 per cent density, which would mean that the locomotive smoke would still be 29 per cent of the total, and probably be responsible for over one-third of the dirt. The modern steam loco-

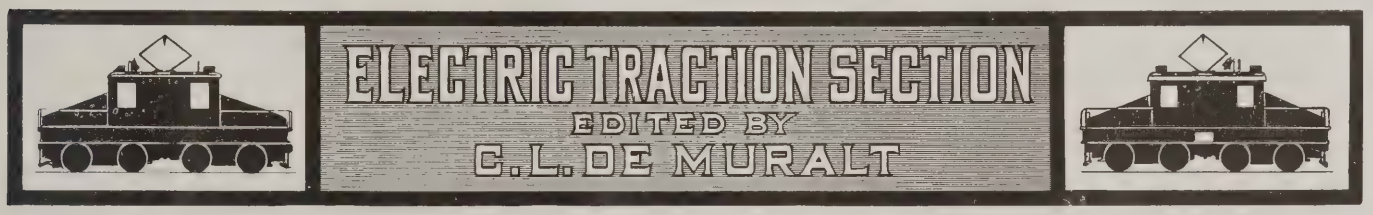
TABLE III.

DATA ON RAILROAD TRACKS - LOCOMOTIVES & COAL
COMPILED DURING SUMMER OF 1910

| No | RAILROAD COMPANY | MILES OF TRACK IN CITY LIMITS | | | LOCOMOTIVES | | | | | | | | | COAL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AVERAGE NUMBER IN CHICAGO AT ONE TIME | | | TOTAL NUMBER OF DIFFERENT LOCO'S IN CHICAGO DAILY | | | TOTAL NUMBER OF DIFFERENT LOCO'S IN CHICAGO WEEKLY | | | TONS PUT ON ENGINES IN CHICAGO DAILY | | | TONS BURNED WITH IN CITY LIMITS DAILY | | |
| | TRUNK LINES | MAIN | SIDE | TOTAL | PASS | FREIGHT | TOTAL | PASS | FREIGHT | TOTAL | PASS | FREIGHT | TOTAL | PASS | FREIGHT | TOTAL | PASS | FREIGHT | TOTAL |
| 1 | A. T. & SANTA FE R.Y. CO. | 13.28 | 43.82 | 57.10 | 10 | 24 | 34 | 10 | 24 | 34 | 19 | 35 | 54 | 52 | 158 | 210 | 25 | 75 | 100 |
| 2 | BALTIMORE & OHIO RR. | 16.14 | 25.67 | 41.81 | 5 | 20 | 25 | 10 | 32 | 42 | 10 | 32 | 42 | 65 | 195 | 260 | 19 | 56 | 75 |
| 3 | CHICAGO & WESTERN INDIANA R.R. | 50.32 | 99.71 | 150.03 | 3 | — | 3 | 3 | — | 3 | 3 | — | 3 | 30 | 55 | 85 | 30 | 55 | 85 |
| 4 | CHICAGO & ALTON R.R. | 14.22 | 32.60 | 46.82 | 5 | 19 | 24 | 10 | 29 | 38 | 10 | 29 | 39 | 85 | 232 | 317 | 9 | 134 | 143 |
| 5 | CHICAGO BURLINGTON & QUINCY RR. | 11.34 | 80.17 | 91.51 | 20 | 73 | 93 | 41 | 73 | 114 | 59 | 100 | 159 | 150 | 300 | 450 | 50 | 215 | 265 |
| 6 | C & O R.R CO. OF IND. FORMERLY C.C.&L. | — | — | — | 2 | 3 | 5 | 2 | 3 | 5 | 2 | 3 | 5 | 12 | 21 | 33 | 1 | 6 | 7 |
| 7 | CHICAGO & EASTERN ILLINOIS RR | — | — | — | 8 | 12 | 20 | 12 | 13 | 25 | 12 | 13 | 25 | 19 | 58 | 77 | 24 | 52 | 76 |
| 8 | CHICAGO GREAT WESTERN R.R. | — | 16.01 | 16.01 | 4 | 12 | 16 | 5 | 20 | 25 | 5 | 20 | 25 | 32 | 100 | 132 | 15 | 48 | 63 |
| 9 | CHICAGO INDIANAPOLIS & LVILLE RY. | — | — | — | 4 | 3 | 7 | 6 | 5 | 11 | 6 | 5 | 11 | — | 8 | 8 | 4 | 10 | 14 |
| 10 | CHICAGO IND. & SOUTHERN RR CO. | — | — | — | 2 | 2 | 4 | 3 | 4 | 7 | 3 | 4 | 7 | 18 | 32 | 50 | 1 | 8 | 9 |
| 11 | CHICAGO MILWAUKEE & ST PAUL RY. | 54.66 | 103.01 | 157.67 | 18 | 76 | 94 | 34 | 96 | 130 | 56 | 145 | 201 | 172 | 598 | 770 | 49 | 467 | 506 |
| 12 | CHICAGO & NORTHWESTERN RAILWAY | 66.89 | 234.34 | 303.23 | 135 | 188 | 323 | 135 | 188 | 323 | 135 | 188 | 323 | 500 | 1500 | 2000 | 264 | 786 | 1060 |
| 13 | CHICAGO ROCK ISLAND & PACIFIC R.Y. | 35.94 | 76.99 | 112.93 | 17 | 17 | 34 | 33 | 27 | 60 | 222 | 166 | 388 | 52 | 158 | 210 | 88 | 118 | 206 |
| 14 | ERIE RAILROAD | — | — | — | 4 | 9 | 13 | 6 | 14 | 20 | 11 | 34 | 45 | 43 | 70 | 113 | 11 | 73 | 84 |
| 15 | GRAND TRUNK RAILWAY SYSTEM | 17.04 | 26.25 | 43.29 | 4 | 16 | 20 | 8 | 25 | 33 | 8 | 25 | 33 | 53 | 137 | 190 | 20 | 60 | 80 |
| 16 | ILLINOIS CENTRAL RAIL ROAD | 149.00 | 167.63 | 316.63 | 67 | 81 | 148 | 70 | 106 | 176 | 70 | 106 | 176 | 502 | 400 | 902 | 300 | 200 | 500 |
| 17 | LAKE SHORE & MICH. SOUTHERN RY. | 11.42 | 73.85 | 85.27 | 22 | 43 | 65 | 26 | 48 | 74 | 181 | 324 | 505 | 180 | 383 | 563 | 78 | 231 | 309 |
| 18 | MICHIGAN CENTRAL RAILROAD | 7.58 | 42.60 | 50.18 | 5 | 18 | 23 | 15 | 20 | 35 | 15 | 20 | 35 | 44 | 131 | 175 | 22 | 68 | 90 |
| 19 | NEW YORK CHICAGO & ST LOUIS R.R. | 8.70 | 29.51 | 38.21 | 4 | 22 | 26 | 6 | 25 | 31 | 6 | 25 | 31 | 35 | 112 | 147 | 10 | 55 | 65 |
| 20 | PENNSYLVANIA RAILROAD CO. | 89.72 | 164.19 | 253.91 | 19 | 126 | 145 | 35 | 153 | 188 | 243 | 1071 | 1316 | 80 | 567 | 647 | 80 | 567 | 647 |
| 21 | PERE MARQUETTE RAILROAD | — | — | — | 5 | 4 | 9 | 8 | 2 | 10 | 52 | 3 | 55 | 30 | 20 | 50 | 10 | 20 | 30 |
| 22 | WABASH RAILROAD | 9.84 | 28.68 | 38.52 | 3 | 18 | 21 | 10 | 18 | 28 | 10 | 30 | 40 | 60 | 140 | 200 | 15 | 75 | 90 |
| 23 | MINN. ST P & S STE M RY LEASED OF WC | — | — | — | 6 | 9 | 15 | 6 | 9 | 15 | 6 | 9 | 15 | — | 6 | 6 | 13 | 39 | 52 |
| | BELT OR TRANSFER RAILROADS | | | | | | | | | | | | | | | | | | |
| 1 | B & O CHICAGO TERMINAL RR | 33.93 | 50.77 | 84.70 | 2 | 23 | 25 | 2 | 23 | 25 | 2 | 23 | 25 | 19 | 57 | 76 | 25 | 75 | 100 |
| 2 | BELT RAILWAY OF CHICAGO | 32.24 | 66.36 | 98.60 | — | 82 | 82 | — | 82 | 82 | — | 82 | 82 | — | 425 | 425 | — | 425 | 425 |
| 3 | CHICAGO JUNCTION RAILWAY | 5.80 | 4.20 | 10.00 | — | 37 | 37 | — | 37 | 37 | — | 37 | 37 | — | 296 | 296 | — | 296 | 296 |
| 4 | CHICAGO RIVER & INDIANA R.R. | — | — | — | — | 4 | 4 | — | 4 | 4 | — | 4 | 4 | — | 32 | 32 | — | 32 | 32 |
| 5 | CHICAGO UNION TRANFER RY. | — | — | — | — | 1 | 1 | — | 1 | 1 | — | 1 | 1 | — | — | — | — | 2 | 2 |
| 6 | CHICAGO WEST PULLMAN SOUTHERN RR. | — | — | 10.00 | — | 10 | 10 | — | 10 | 10 | — | 10 | 10 | — | 40 | 40 | — | 40 | 40 |
| 7 | CHICAGO & CALUMET RIVER R.R. | 2.19 | .10 | 2.29 | — | 2 | 2 | — | 2 | 2 | — | 2 | 2 | — | 6 | 6 | — | 6 | 6 |
| 8 | ELGIN JOLIET & EASTERN RY. | 3.52 | 15.73 | 19.25 | — | 45 | 45 | — | 45 | 45 | — | 45 | 45 | — | 121 | 121 | — | 121 | 121 |
| 9 | INDIANA HARBOR BELT R.R. | 10.25 | — | 10.25 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 10 | ILLINOIS NORTHERN RAILWAY | 12.25 | — | 12.25 | — | 5 | 5 | — | 5 | 5 | — | 5 | 5 | — | 24 | 24 | — | 24 | 24 |
| 11 | MANUFACTURER'S JUNCTION R.Y. | — | 1.16 | 1.16 | — | 3 | 3 | — | 3 | 3 | — | 3 | 3 | — | 9 | 9 | — | 9 | 9 |
| 12 | UNION STOCK YARDS | 17.31 | 129.37 | 146.68 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | TOTAL | 669.58 | 1512.72 | 2182.30 | 374 | 1007 | 1381 | 496 | 1140 | 1636 | 1148 | 2593 | 3741 | 2233 | 6391 | 8624 | 1463 | 4438 | 5601 |

motive is such a highly developed machine that it is extremely unlikely that any change will ever be made in its construction which will produce better results than this. A further reduction of the smoke made by locomotives can only be brought about by change of fuel. The possible fuels besideds the local soft coals are: 1st, semi-bituminous coal; 2d anthracite coal; 3d, coke, and 4th, oil. A considerable amount of semi-bituminous or Pocahontas coal is now being burned by some of the railroads in Chicago, and although it makes less smoke than Illinois coal under the same conditions, its use by no means guarantees the entire elimination of smoke. Probably the universal use of semi-bituminous coal would not succeed in reducing the average density of smoke below a point that is considered possible with Illinois coal. The general use of anthracite coal or of coke for locomotives would eliminate smoke, but the other nuisances due to steam locomotives would not be diminished. If coke were used there would be an increase in the quantity of sparks and cinders discharged from the stacks. Fuel oil makes smoke unless carefully handled, and the smoke that is made is more objectionable than the smoke from soft coal. The general use of any specially selected fuel would greatly increase the cost of fuel to the railroads, and the practical difficulties involved would make it a very difficult thing to bring about. The locomotive fireboxes would have to be changed if coke or hard coal were used. In order to insure that all locomotives operating in the city limits used the same fuel all the engines on an entire division would have to be thus equipped, which, of course, would greatly increase the cost of operation.

The study that has been made along these lines indicates clearly that electrification offers the only final and satisfactory solution of the locomotive smoke problem. The use of special fuel for preventing smoke on steam locomotives is only a makeshift, and will not satisfy the public.




# Modern Tendencies in Electric Locomotive Design

## SIDE RODS

The earliest electric cars had their motors geared to the axles. The first electric locomotives also.

Then came an era when motors were preferably mounted right on the axles and direct connected to them.

In both of these cases, the motors bear down directly on the axles. In the case of the direct connected motors the entire weight is on the axles. In the case of gear connected motors about one-half of the weight is on the axles, and the other half may be spring-supported from the frame.

It would be a great advantage if the entire motor weight could be spring-supported on the frame.

This can only be done if some intermediate link is introduced between the motor and the driven axle. The side rod or connecting rod is the natural solution.

### Side Rods Used in Europe.

In European practice, side rods have been used for a great many years. Fig. 1 shows diagrammatically one of the first electric locomotives used in trunk line service, one of the original three-phase locomotives of the Valtellina Railway in Italy. The cranks of the two motors are connected by a triangular shaped bar. The lower point of this bar contains a slot which engages the crank pin of the center or main driving wheel. The crank pin bearing is contained in a cross head, which is free to move up and down vertically in the slot whenever there is any relative vertical motion between the driving axle and the spring supported motors. The center driving wheel is connected through side rods with the other wheels on either side.

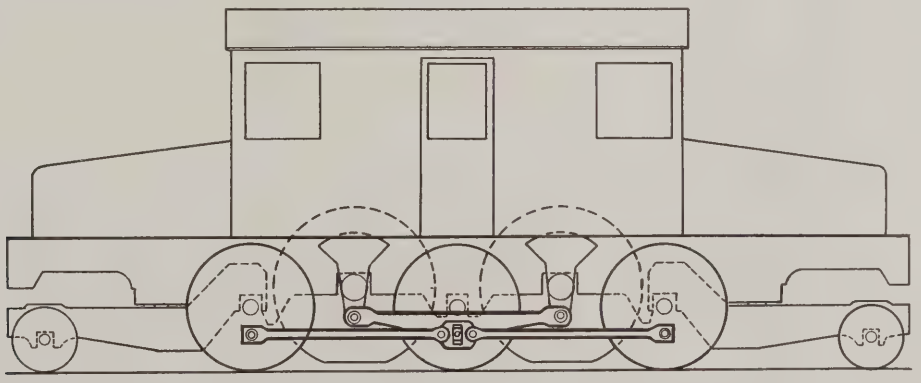


Fig. 1. Early Italian Three Phase Locomotives.

This gives an admirable driving mechanism which has been used over and over again in European trunk line work.

In America, engineers were at first opposed to the use of side rods. They probably had in mind the deleterious effects of the unbalanced reciprocating parts of a steam engine and they reasoned that, if it was possible to do without similar parts on the electric locomotive, it was well to do so.

There is a fallacy connected with this reasoning.

Side rods employed in electric service are not reciprocating parts at all.

If we go back for a moment and carefully look at the various parts of the driving mechanism of a steam engine the point will be quite plain. On the steam engine we have first of all the piston and piston rod, quite plainly reciprocating parts. The cross head also is a reciprocating part. The coupling rod, which connects the cross head with the first crank pin, has one end reciprocating, the other end rotating. The action of the coupling rod as a whole is reciprocating. But when we come to side rods which connect the main crank pins with their neighbors, then we find that these side rods have a purely rotating action and no reciprocating motion at all. The effect of their slightly eccentric position with reference to the driving axles can be accurately counter balanced. These side rods have, therefore, no deleterious action whatever on the track or on any other part.

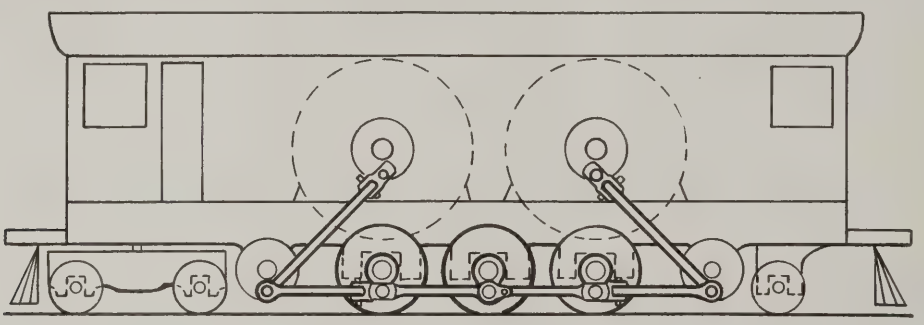


Fig. 2. First Side Rod Locomotives Built in America.

### Advantages of Side Rods.

The side rods in an electric lomotive are strictly comparable to the side rods in a steam engine. Their action is purely rotating and there is thus no reason whatever why they should not be employed if they present any particular advantages.

Side rods do present two very important advantages:

First, they allow the entire motor weight to be spring supported from the locomotive frame.

Second, they enable the center of gravity of the lomotive to be raised to any desired point.

As regards the first point, it is self-evident. Fig. 2 represents diagrammatrically the first experimental side rod locomotive built in America by the General Electric Company, of Schenectady. The latest Pennsylvania locomotives built by the Westinghouse Company show a very similar arrangement.

The motor or motors are raised above the locomotive floor and therefore they are mounted just as one would mount any ordinary motor on a shop floor or anywhere else. The motors drive by means of an inclined side rod a counter shaft, or counter shafts hung from the lower part of the frame. The position of these counter shafts is such that from them the locomotive axles can be driven by means of side rods in practically horizontal position.

The only thing in this arrangement which gives rise to some doubts as to its being properly chosen is the strongly inclined side rod. Thus far, however, no bad effects appear to have been noticed, due to this point.

The design secures, not only the possibility of spring supporting the entire motor weight, but also the opportunity to raise the center of gravity of the locomotive as a whole.

On this point also it is interesting to follow the change which has taken place in public opinion in America.

When the first European three-phase locomotives were built, they were severely criticized here, due to their high center of gravity. It was claimed that the low center of gravity of the American locomotives of that day was a very strong point in their favor, indeed it was thought that it was a very strong point in favor of the electric locomotive as compared with the steam locomotive, as the latter must necessarily have a rather high center of gravity.

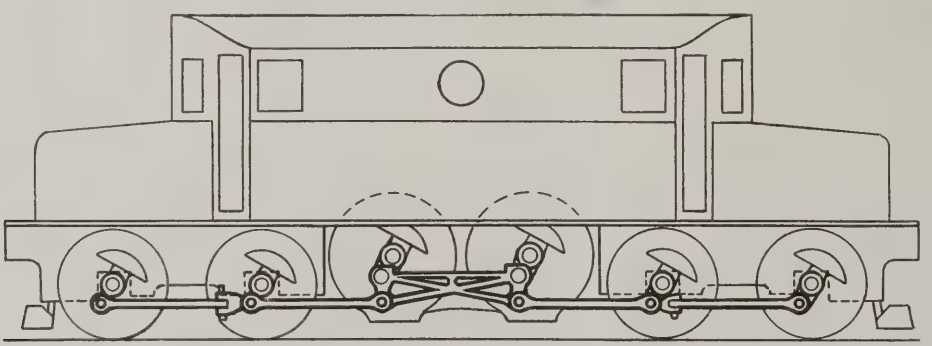


Fig. 3. Latest European Locomotives.

### High Center of Gravity Preferable.

Certain things happened, however, which went to show that, while a low center of gravity might tend to increase the stability of the locomotive, it would also tend to increase the severe action of the rail and wheel flanges upon one another in curves. In other words, a high center of gravity would allow the locomotive to lean over a little and thus relieve the strain which is brought upon the point of contact between wheel and track by the inertia of the weight of the moving train.

It is therefore generally accepted today that the raising of the center of gravity is beneficial.

Just how far it should be carried to obtain the best results, without making the locomotive top heavy, has not yet been definitely established. It is the impression of the writer that the movement, like so many fads, has been carried rather too far. It will remain to careful investigation to accurately establish this point.

Certain it is that a ride on some of the latest European three-phase locomotives strengthens this impression.

These locomotives, shown diagramatically in Fig. 3, have the center of gravity considerably higher than earlier types of electric locomotives, yet not as high as the type represented by Fig. 2. They relieve the track very well of the strain mentioned above. Yet, they are much more stable and therfore much more comfortable to ride in at high speeds than those of Fig. 2.

The driving mechanism used on these locomotives is of considerable interest. The locomotive has four driving axles and the two motors are spring supported from the frame between the two center axles. The motors are connected together by means of an X-shaped side bar, which not only inter-connects the

Pennsylvania Locomotive—Motors and Running Gear.

two halves of the locomotive, but at the same time lowers the point of drive so that the side rods going to the crank pins of the driving wheels assume practically horizontal position.

The arrangement is extremely simple and has proved itself to be very efficacious in actual service.

The next step in the development may well be the combination of a gear drive with a side rod drive. Let the motor be mounted on the locomotive frame in whatever position is most suitable. Let it be a high speed motor driving a counter shaft by means of gearing. Let this counter shaft be placed in such a position that from its crank pins the cranks on the drivers can be driven by practically horizontal side rods.

You then obtain the advantages of entirely spring supported motor and of higher center of gravity and, in addition, the higher speed of the motor allows you to reduce the locomotive weight as a whole and thus naturally its cost as well.

An experimental locomotive embodying these features is now being built by the University of Michigan and will probably be in operation within a month.

The question of driving mechanism is one of the most important questions in connection with the design of electric locomotives and further developments along this line will be watched with great interest.

## PENNSYLVANIA RAILROAD ORDERS NINE MORE ELECTRIC LOCOMOTIVES.

Nine more electric locomotives, aggregating about 40,000 horsepower, have been ordered by the Pennsylvania Railroad from the Westinghouse Electric & Manufacturing Company. The new locomotives will be of the same type as those which are now being operated in the Manhattan Terminal, New York City, and will supplement the twenty-four already in use. The Westinghouse Electric & Manufacturing Company has contracted to have the new locomotives completed by July 1, 1911.

The cabs, frames, running gear and mechanical parts will be built by the Pennsylvania Railroad at their Juniata shops. The air brakes will be suplied by the Westinghouse Air Brake Company. The electrical equipments will be built and the complete locomotives assembled at the East Pittsburg Works of the Westinghouse Electric & Manufacturing Company.

The Pennsylvania locomotives are by far the most powerful ever built. The locomotive is an articulated machine of double cab design. Each half carries its own motor and complete equipment and the two halves are coupled together at their driving-wheel ends. The frames, driving wheels and trucks of the running gear are similar in general character to those of the "American Type" steam locomotive.

The following are some of the characteristic features of the Pennsylvania direct-current, 600-volt electric locomotives:

WEIGHTS AND DIMENSIONS

| | |
|---|---|
| Weight of locomotive, complete | 156 tons |
| Weight on drivers | 200,000 lbs |
| Weight on each driving axle | 50,000 lbs. |
| Weight on each bogie truck | 57,000 lbs |
| Total length overall, inside knuckles | 64 ft., 11 in. |
| Rigid wheel base of each half | 7 ft., 2 in |
| Total wheel base of each half | 23 ft., 1 in. |
| Total wheel base of locomotive | 55 ft., 11 in |
| Diameter of drivers | 72 inches. |

GENERAL CAPACITY

| | |
|---|---|
| Contract tractive effort | 60,000 lbs. |
| Maximum draw bar pull (recorded on test) | 79,200 lbs. |
| Normal speed with full train | 60 mi. per hr. |

NORMAL SERVICE

**550-Ton Train to be Started and Accelerated on 2 Per Cent Tunnel Grades**

| | |
|---|---|
| Maximum Contract horse-power | 4,000. |

MOTOR DATA

**Two Direct-Current Interpole Motors—Cast Steel Frames—Directly Connected Through Jack-Shafts and Side-Rods**

| | |
|---|---|
| Weight of each motor complete with cranks | 43, 000 lbs. |
| Height of motor frame above cab floor | 5 ft., 6½ in. |
| Height of center of shaft above cab floor | 2 ft., 1½ in |

The wheel and motor arrangement was decided upon only after careful experiments with several other forms, both of motor drive and wheel arrangement; the governing motive being to secure the greatest possible steadiness at speed.

The coupled ends are fitted with permanent couplings of twin draw bars and Westinghouse friction draft gears, so arranged that the leading half serves as a leading truck and the other half as a trailer in whichever direction the locomotive may be moving.

Each cab is complete with Westinghouse automatic and straight air brake equipment, apparatus for train lighting, electric headlights, pneumatically operated whistle and sanders, as well as its motor, unit switches and master controller.

The machines are so arranged that, in event of one motor being cut out, the entire machine can be operated from either cab with the remaining motor. The halves are interchangeable and if one is out of service

it may be replaced by another half while repairs are being made.

The unit switch field control permits two or more locomotives to be coupled together and all to be operated from either end of any one cab, and affords flexibility of speed regulation. It gives two additional running notches and at the same time economizes power consumption during acceleration.

Since the opening of the Manhattan Terminal on November 27, 1910, the entire through passenger traffic of the Pennsylvania road in its Newark tunnels has been handled by the electric locomotives of this type without a hitch and to the entire satisfaction of the operating force. Very heavy trains, far beyond the capacity of the usual passenger locomotive, have been handled over the tunnel grades with ease.

## GERMAN RESULTS WITH STORAGE BATTERY CARS.

Some exceedingly interesting tests were made recently in Halle, Germany, with a six-axle storage battery car designed and built by the Halle railways.

The tests were made on the line from Kottbus to Schoenwalde, which is forty miles long.

The table shows up a few things very nicely.

First of all it will be remarked that the energy consumption is quite a little higher with the increased speed.

Comparing the runs at 30 miles per hour and 10 stops with the run at 37.5 miles per hour and 10 stops, we find that the energy consumption increased from 61 and 63 kilowatt-hours respectively to 67.5 and 66.5 kilowatt-hours respectively.

Then it will be noticed that any increase in number of stops also increased the energy consumption materially.

Compare the run at 37.5 miles and 1 stop with the run at the same speed and 10 stops. In the first case 52.5 kilowatt hours. In the second 67.5 kilowatt-hours.

Finally it will be noted that it was possible in this instance, by decreasing the number of stops to increase the speed materially and yet actually to decrease the energy consumption.

The average energy consumption of this 60-ton car running at speeds from 30 to 37.5 miles per hour may be said to have been between 20 and 24 watt-hours per ton mile.

The car can run 62½ miles on one charge.

Pennsylvania Electric Locomotive and 8-Car Train at Tunnel Entrance, New York City.

The car weighs 60.5 tons and was loaded with six tons artificial load to represent passengers.

The route was first traversed at a speed of thirty miles an hour, stopping at all stations, then at 37.5 miles an hour without stopping, and finally at 37.5 miles an hour with all regular stops.

The results are shown in the following table:

### Data from Storage Battery Car Operation.

DATA FROM STORAGE BATTERY CAR OPERATION.

| State of Rails | Speed in Miles per Hour | Number of Stops | | Energy Consumption (Kw. Hours) | | Watt-Hours per Ton Mile | |
|---|---|---|---|---|---|---|---|
| | | Going | Return | Going | Return | Going | Return |
| Damp | 30 | 10 | 10 | 61 | 63 | 22.9 | 23.7 |
| Damp | 37.5 | 1 | 3 | 52.5 | 53.5 | 19.8 | 20.0 |
| Dry | 37.5 | 10 | 10 | 67.5 | 66.5 | 25.3 | 24.9 |

The battery in this car consists of 168 cells and has a rating of 368 ampere-hours.

## ELECTRIFICATION OF KONGO RAILWAY.

A study is being made of conditions on the Kongo river between Matadi, near the mouth of the Congo, and Leopoldville, for obtaining power to electrify the railway between the two places operated by the Compagnie du Chemin de Fer du Kongo. This railway is the connecting link between the Upper and Lower Kongo, and is about 250 miles in length. The river has numerous rapids and falls between the two places, from which it is expected to obtain the necessary power. Freight and passenger rates are at present high, accommodations inadequate, and two days are required to make the trip from Leopoldville to Matadi. —*Mining and Scientific Press.*

## NEW YORK CENTRAL'S ELECTRICAL EXTENSION.

Beginning with February 2, all local trains on the Hudson River Division of the New York Central and Hudson River Railroad have been electrically operated as far as Hastings. Thus far the terminal of the electric zone was at Yonkers.

This adds two and one-half miles to the electric zone on this division.

The use of electricity shortens the running time between Grand Central Station and Hastings by over two minutes.

## HOOSAC TUNNEL ELECTRIFICATION.

Last month we reported on the progress of the line work inside the tunnel. This month we are able to report on the rolling stock.

Two of the new electric locomotives of the Boston and Maine which will be used in the Hoosac Tunnel service, have been delivered to the New Haven Railroad. They are to be tried out on the electrified section of the latter company near New York.

The work on the tunnel installation is progressing rapidly and it is expected that it will be completed at an early date.

## THE TIDE CONTINUES TO TURN.

In our last issue we called attention to the change in sentiment which is taking place, from the old war cry for a single and universal system of electrification to the more modern admission that there is room for all and that each system possesses advantages of its own which make it most suitable under certain conditions.

As an illustration we referred to the interesting series of advertisements on "Electricity in Heavy Railroad Service," which began to appear in technical papers shortly after New Year's.

The series has been continued and is emphasizing the points previously made.

As presumed, talk No. 4, on January 27, treated on Three-Phase Equipment:

"The time has arrived when *utilization of electric economy* on large railroads *must be considered.*

"The Westinghouse Electric and Manufacturing Company was the first in America to apply alternating current to practical railway service."

"Its superior development of the Three-Phase system is evidenced in the recent award by the *Italian State Railways* to the Società Italiana Westinghouse of the contract for the Three-Phase electrification of the Giovi line, together with forty locomotives for freight and passenger service. It is required that *any two locomotives be able to haul a* 380-*ton train up a* 3.5 *per cent grade with* 1200 *feet radius curves.*"

This is truly a tremendous requirement!

"*The Three-Phase System* is adapted for service on mountain divisions with variable grades where constant speed is economically desirable."

"The advantage from constant speed under all loads within the capacity of the motors, irrespective of grade, may be fully realized and overspeeds are impossible."

"Good traction power is obtained with comparatively lightweight motors."

"Alternating current in its most economical transmission development is available in Three-Phase operation."

"Motors may be used as generators during electric braking."

The four advantages of the Three-Phase system, constancy in speed, light weight of motors, efficiency in transmission, and recuperation of energy in braking, are very well put.

On February 3, Talk No. 5:

"Presents a *Concise Summary* of economic characteristics with interesting brevity."

"*The Direct-Current System* was the first in the field and has advantages in the operative characteristics of the motor; simplicity and ruggedness with high power, variable speed and ease of control."

"The limitations of the system are found in the high cost and low efficiency of the transmitting and distributing system and in conversion losses, especially in moving heavy trains over long distances."

This statement is probably correct today, but the coming of higher and higher direct-current pressures is gradually reducing these limitations.

"*The Single-Phase System* gives operative qualities similar to those of Direct-Current."

"The first cost of the transmitting and distributing installation is low."

"The first cost and weight of Single-Phase rolling stock is higher than that of Direct-Current."

"The limitations of Single-Phase operation have not yet been determined."

On this last point the advertisement writer is evidently misinformed. The limitations of the Single-Phase System are very well known, and they are much more serious than those of the other systems. Indeed, they are so serious that some of the best posted engineers of today consider the Single-Phase System unsuited or at least inefficient for real heavy work.

"*The Three Phase System* is adapted for roads where constant speed is economical."

"The cost and weight of the motors is comparatively low, and regeneration of power is possible with electric braking."

The fourth advantage, high efficiency of transmission, is here overlooked, though it has been previously mentioned.

"*In Choice* between the three systems in America, local conditions should be considered, but the coming general electrification of important railroad divisions must be held in view."

This is mighty good advice, indeed!

On February 10, Talk No. 6 brings a description of three representative trunk line electrifications carried through by the Westinghouse Company.

The Pennsylvania Long Island Installation is a good example of Direct-Current Practice.

The New York, New Haven & Hartford's New York City Terminal Electrification represents the Single-Phase System, and

The Italian State Railway's Giovi Line, near Genoa, illustrates the use of Three-Phase Equipment.

Each one of these is an important trunk line in the full sense of the word.

On February 17, Talk No. 7 describes the locomotives used on the three installations just named.

It is interesting to note that the Pennsylvania Direct-Current Locomotive weighs 165 tons and develops 4000 horsepower, which corresponds to 24.2 horsepower per ton.

The New Haven Single-Phase Locomotive weighs 103 tons and develops 1000 horsepower, or 9.7 horsepower per ton, and

The Giovi Three-Phase Locomotive weighs 60 tons and develops 2000 horsepower, or 33.3 horsepower per ton.

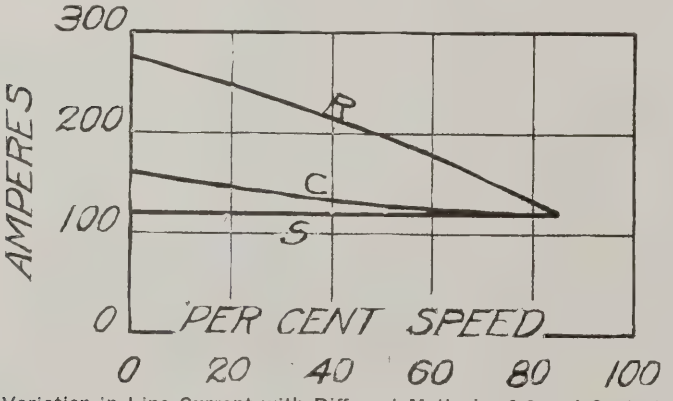
We hope that this series of advertisements will continue for some time to come, as it is certainly by far the most interesting advertising matter we have read in a long time and its broad purpose of acquainting the railroad world with the advantages of the three best known systems of electrification is highly commendable.

# Variable Speed Induction Motors

There are so many kinds of induction motors now on the market that something suitable for any given service should be easy to obtain. But, for driving machine tools and other railway shop equipment, it is generally necessary to have a motor which can be operated at various speeds. Certain conditions such as lathe and boring mill service have until recently demanded shunt or compound wound direct current motors, but competition among manufacturers of motors under pressure by users has developed the variable speed induction motor to its present state of comparative perfection. The Readville shops of the N. Y., N. H. & H. R. R. offer a good example of what induction motors can be made to do, and the series of articles just closing in this paper describes the equipment fully.

### Various Forms.

Broadly speaking, there are three forms of induction motors, all of which lend themselves to speed variation within certain limits by the use of suitable devices. First is the form with the "squirrel cage," or short-circuited rotor. These have comparatively



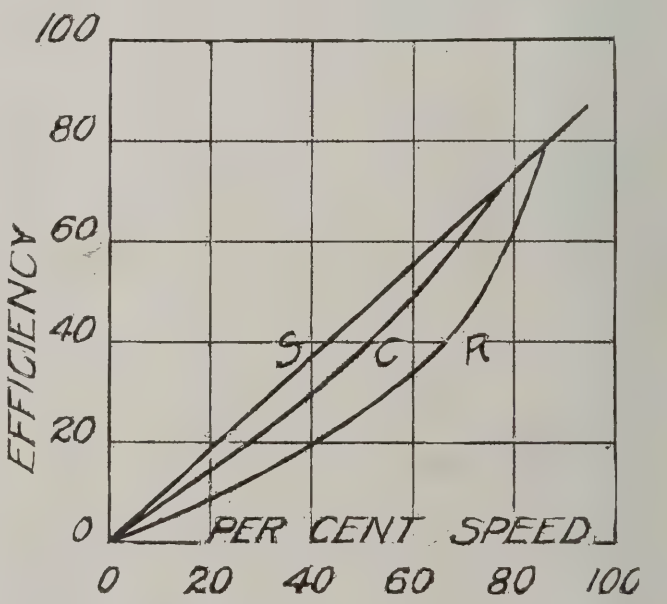

Variation in Line Current with Different Methods of Speed Control.

small starting torque per ampere and take from 3 to 6 times full load current at starting. Second is the form with insulated polar windings on the rotor and with an internal starting resistance. They take about one and one-half times full load current at starting and develop about one and one-half times full load torque. The third form, which is best suited to variable speed service, has slip rings on the rotor for the introduction of external resistance. The rotors of these motors are also polar wound and of low resistance, but any desired amount of additional resistance may be put into the rotor circuit through the medium of the slip rings and conections. There are other forms of variable speed induction motors, but as they are all modifications of the foregoing they will not be described here.

### Speed Variations.

There are three methods of varying the speed of induction motors, two of which are based upon "primary control" and the other upon "secondary control." By primary control is meant "varying the stator voltage of a motor having a high resistance rotor," and by secondary control we mean "varying the rotor resistance." Speed control on the primary side of the motor is accomplished by variation of the voltage through a compensator (practically a transformer with extra taps) or by introducing resistance into the primary circuit by means of a rheostat.

Of the three forms of motors mentioned, the first form (that with squirrel cage armature) with compensator is the most expensive, while the third form (that with resistance external to the rotor is the cheapest. This is due to the necessity for a high resistance rotor in the first form, bringing the losses (necessary to obtain reduced speeds) within the machine and making a large motor necessary. With the third form the losses are all in the resistance, which is external to the machine, hence a smaller motor may be built for a given capacity. Compensator control is quite expensive, as well as complicated, because the




Variation in Efficiency with Different Methods of Speed Control.

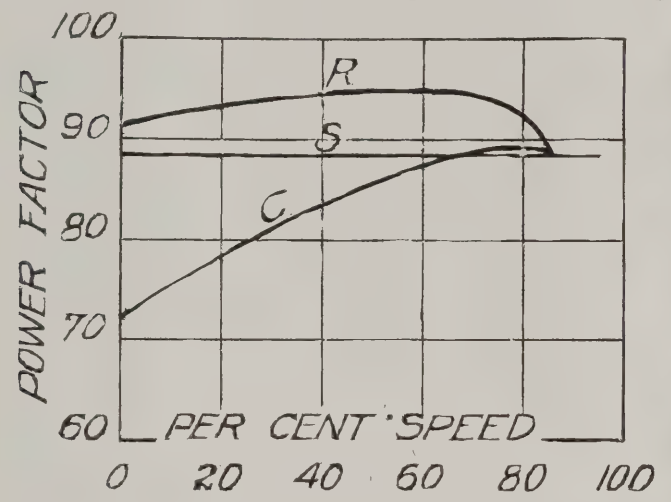
coils of the compensator cannot be short-circuited but must be cut out by a suitable switch.

The third form, or "slip ring" motor with variable secondary resistance, is most suitable for use when a variable speed motor for a large number of speeds is wanted. While motors of this type should not be run for a long time at any fixed and very low speed, they may be operated continuously with full load torque at 50 per cent of rated speed, or above, without injurious heating. Below this speed they usually do not ventilate well.

### Typical Curves.

In order that a comparison may be made as to the variation in current, power factor, efficiency and speed with the three methods of control described herein, the accompanying curves are given. These are typical curves from one of the leading makers of induc-

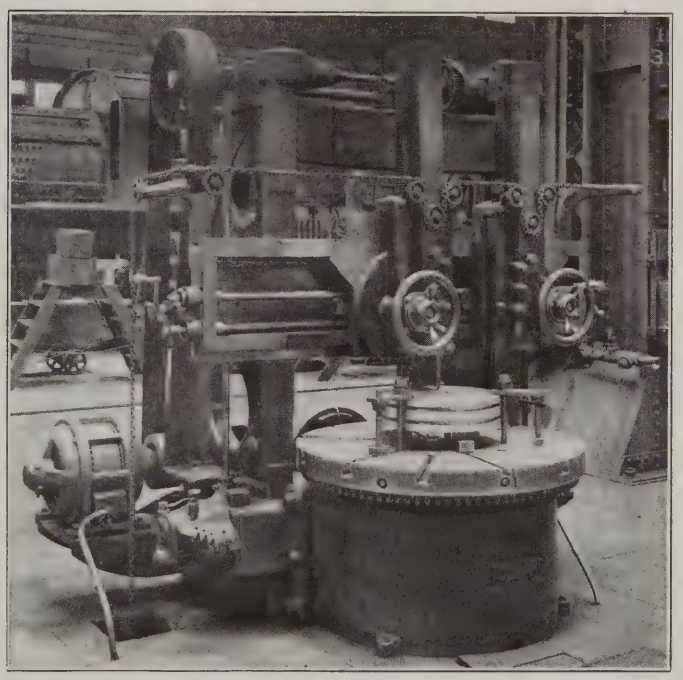
tion motors. The curves marked "R" apply to motors with primary control through resistance; the curves marked "C" apply to motors with primary control with compensators, and the curves marked "S" apply to motors with secondary control as above described. In all cases the curves show the variations as the motor comes up to normal speed exerting full load torque. The great advantages incident to using




Variation in Power Factor with Different Methods of Speed Control.

motors with slip rings and having the resistance external to the rotor may be readily noted, because the efficiency and power factor are higher and current taken from the line is lower than with the other motors at nearly all points. The power factor of the first form is slightly higher, but the other functions are more important.

It is important that motors of sizes suitable to the work should be chosen, for the power factor falls off



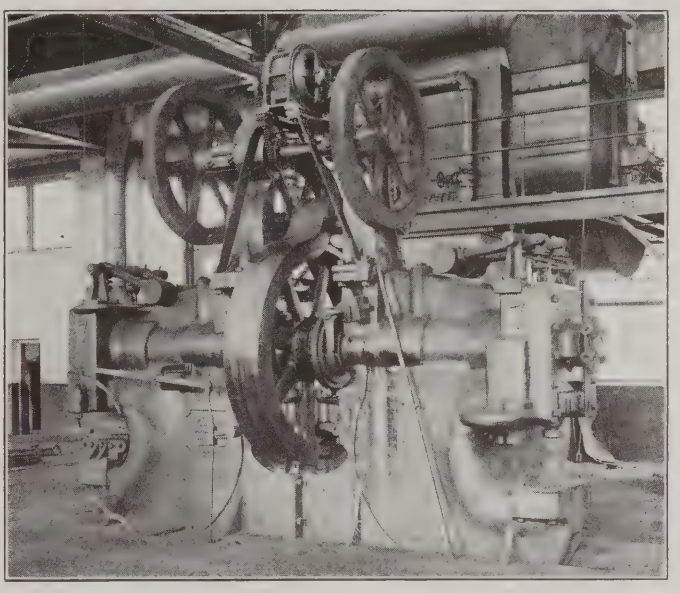
7½-H. P. Induction Motor Belt Connected to 51-Inch Boring Mill.

rapidly when motors run at reduced loads. If the motors are too large the power factor of the entire distribution system will be reduced, and if they are too small they may overheat, will be reduced in efficiency and have less reserve capacity for load fluctuations, although the power factor may be slightly improved.

## THE NEW HAVEN SHOPS AT READVILLE.

(Continued from the February Number.)

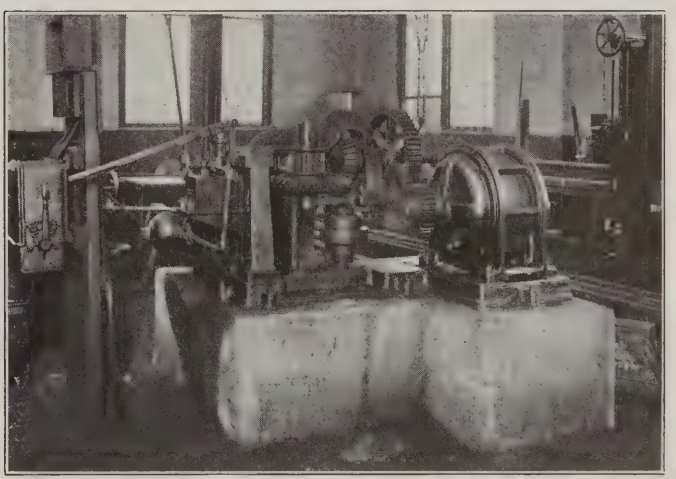
In concluding this series of articles describing the Readville repair shop, attention is especially directed to the fact that approximately 80 per cent of the motors used are the General Electric Co.'s Form K induction motors with compensators on the primary side for speed control. About 15 per cent of these motors



No. 7 Punch and Shear Driven by 15-H. P. Induction Motor.

are the Form L, with starting resistance mounted inside the rotor, these being used for constant speed work on group driven tools, blowers, etc., similar to synchronous motors, and about 5 per cent of the motors are Form M, with speed regulating resistance external to and in series with the rotor windings.

Attention is called to this because the Form M motors are of a type which allow the greatest range



10-H. P. Induction Motor Driving Rail Bender.

of speed control and which show the best average all-round characteristics of any of the induction motors. The accompanying article on "Variable Speed Induction Motors" gives some of the principal features of the various forms of motors, and the curves shown are taken from G. E. C. Form I T C motors. These are a modification of their Form M motors with secondary control, and operate in a manner similar to shunt wound direct current motors with rheostatic armature control.

The accompanying tables show the results of tests

## GROUP DRIVES IN THE READVILLE SHOPS.

### GROUP (GALLERY), 7½ H.P. MOTOR

| Machines | Load | Kilowatt Input |
|---|---|---|
| 1 Two spindle irregular moulder (Carey) | Running light | |
| 1 39½ in. band saw (Carey) | Running | |
| 1 Double saw table (Carey) | Running | 7. |
| When test was made saw was ripping 2 in. pine and saw bench ripping 2 in. oak. | | |

### GROUP, 10 H.P. MOTOR

| | | |
|---|---|---|
| 4 Flue cutters | 2 Running light<br>2 Running | |
| 1 Flue welder | Running | |

### GROUP, 10 H.P. MOTOR

| | | |
|---|---|---|
| 1 28 in. Vertical drill (Blaisdell) | Running | |
| 1 40 in. Vertical drill (Bement) | Running | |
| 1 38 in. Vertical drill (Prentice) | Running | |
| 2 34 in. Lathes (Putnam) | 1 Running | |
| 5 22½ in. Vertical drills (Barnes) | 1 Running | 6.2 |

### GROUP, 15 H.P. MOTOR

| | | |
|---|---|---|
| 3 24 in. Lathes (Reed) | 2 Running | |
| 1 40 in. Vertieal drill (Bement) | | |
| 1 42 in. Boring mill (Bullard) | Running | |
| 1 24 in. Shaper (Stockbridge) | | |
| 1 15 in. Slotter (Betts) | | |
| 1 18 in. Slotter (Putnam) | Running | |
| 1 30 ton Arbor press (Chambersberg) | | 8. |

### GROUP, 30 H.P. FORM L INDUCTION MOTOR

| | | |
|---|---|---|
| 1 No. 300 hollow mortiser (Wood) | Running | |
| 1 No. 225 hollow mortiser (Greenlee) | Running | |
| 1 30 in. single planer (Rogers) | Running | |
| 1 30 in. single planer (Fay) | Running | Av. 22.2<br>Max. 30.3 |
| Heavy load. | | |

### GROUP, 35 H.P., 500 R.P.M. MOTOR

| | | |
|---|---|---|
| 2 irregular moulders (Wood) | 2 Running | |
| 1 60 in. three drum sander (Fay) | Running | |
| 1 42 in. three drum sander (Fay) | Running | |
| 2 grindstones | Running | |
| 1 42 in. band saw (Fay) | Running | |
| 2 turning lathes (Wood) | | |
| 1 dowel machine (Fay) | | |
| 1 rip saw | Running | |
| 2 copper sheathing machines | | 26.3 |
| Heavy load. | | |

### GROUP, 40 H.P. FORM L INDUCTION MOTOR

| | | |
|---|---|---|
| 1 No. 214 jounter (Invincible) | | |
| 1 Universal jointer (Fay) | Running | |
| 1 saw table (Roolston Engine Works) | | |
| 1 end tenoner (Berry & Orton) | | |
| 1 5 spindle borer (Wood) | Running | |
| 1 5 spindle borer (Greenlee) | Running | |
| 1 self feed rip saw (Wood) | | 20.3 |

### GROUP, 50 H.P., 500 R.P.M., FORM L INDUCTION MOTOR

| | | |
|---|---|---|
| 1 chain mortiser (New Britain) | | |
| 1 buzz planer and drill (Fay) | | |
| 1 48 in. band saw (Fay) | Running | |
| 1 10 in. outside moulder (Wood) | Running | |
| 1 36 in. band saw (Atlantic) | | |
| 1 tenoner (Fay) | | |
| 1 double cabinet saw (Carey) | | |
| 1 tenoner | | 18.3 |

### GROUP, 15 H.P. MOTOR

| | | |
|---|---|---|
| 2 30 in. by 8 ft. planers (Woodward & Powell) | 2 Running | |
| 1 26 in. by 10 ft. milling machine, planer type (Becker-Brainard) | | |
| 1 5 ft. radial Drill (Bickford) | Running | |
| 2 No. 2 horizontal boring mills (Betts) | 2 Running | |
| 1 25 in. vertical drill (Barnes) | | |

### GROUP (GALLERY), 15 H.P. MOTOR

| | | |
|---|---|---|
| 1 24 in. lathe (Fitchburg) | | |
| 2 20 in. lathes (Schumacher) | 1 Running | |
| 4 18 in. lathes (Prentice) | 2 Running | |
| 5 18 in. lathes (Schumacher) | | |
| 4 2 ft. by 24 in. flat turret lathes (Warner & Swasey) | 2 Running | |
| 2 2 ft. by 24 in. flat turret lathes (Jones & Lampson) | 1 Running | |
| 1 40 in. vertical drill (Bement) | | |
| 1 25 in. vertical drill (Barnes) | | |
| 1 3 in. bolt cutter | | |
| 1 1½ in. bolt cutter (Acme) | | |
| 2 double bolt cutters (Acme) | 2 Running | Av. 12. |
| 1 double bolt cutter (Niles, Bement & Pond) | Running | Max. 24. |

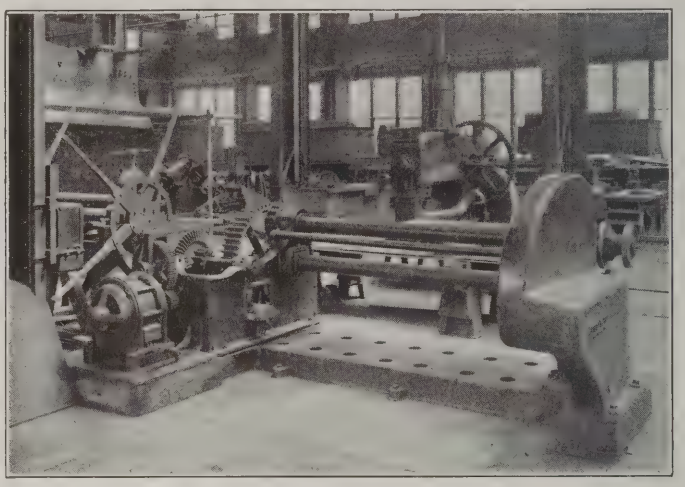
### GROUP, 15 H.P. FORM L INDUCTION MOTOR

| | | |
|---|---|---|
| 1 trip hammer (Bradley) | Running | |
| 1 No. 2 emery grinder (Diamond Machine Co.) | Running | |
| 2 40 in. vertical drills (Bement) | 2 Running | |
| 1 Grindstone | | |
| 1 hammer (Bradley) | | |
| 1 No. 3 shear (Hilles & Jones) | | |
| 1 1½ in. forging machine (Ajax) | | |
| 1 2 in. forging machine (Ajax) | Running | Av. 13. |
| 1 3½ in. forging machine (Ajax) | Running | Max. 19 |

### GROUP, 25 H.P. MOTOR

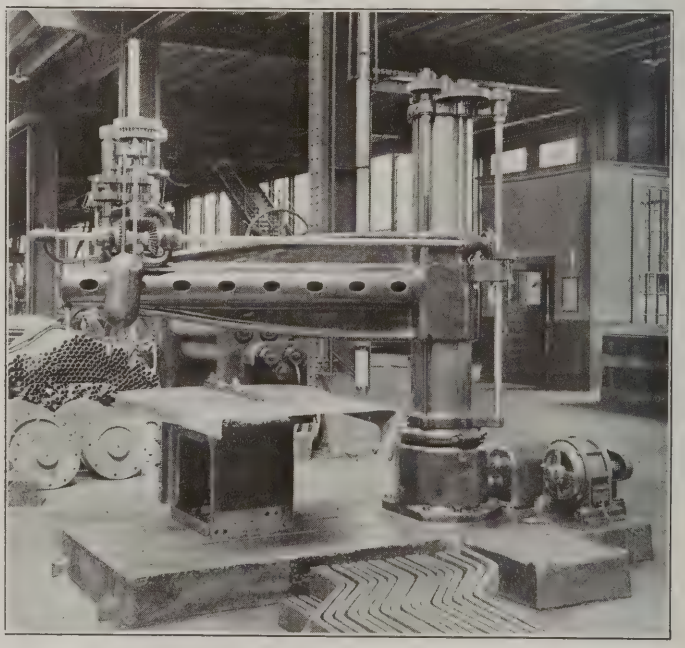
| | | |
|---|---|---|
| 2 30 in. boring mills (Bullard) | 1 Running | |
| 2 24 in. lathes (Reed) | 2 Running | |
| 2 18 in. lathes (Reed) | | |
| 1 24 in. turret lathe (Gisholt) | Running | |
| 1 30 in. planer (Woodward & Powell) | | |
| 1 16 in. shaper (Gould & Eberhardt) | | |
| 1 24 in. shaper (Stockbridge) | Running | |
| 1 16 in. shaper (Stockbridge) | | |
| 1 30 in. planer (Putnam) | | |
| 1 42 in. vertical milling machine (Hilles & Jones) | | |
| 1 double rod borer (Newton) | | 16. |

made on the motors driving the various groups of small tools, and show some of the reasons for using so few motors with secondary control. Groups of tools usually consist of machines which run at constant speeds for given operations, or which have speed changing devices attached to suit conditions. The groups driving metal working tools are operated by Form K induction motors of moderate size, running up to 25 H.P., these motors being better adapted to



Splitting Shears Driven by 7½-H. P. Induction Motor.

constant speed work and continuous operation because they have comparatively small starting torque and require from 3 to 6 times full load current at starting. The groups made up of wood working tools are driven by Form L motors, these having a higher starting torque per ampere than the Form K and somewhat higher efficiency than the Form M motors



5-H. P. Induction Motor Geared to 6-Foot Radial Drill.

of the moderate capacities. The Form L motors require about ond and one-half times full load current when starting and develop about one and one-half times full load torque, so are especially suited for this particular service.

The illustrations herewith show more of the typical machine tools with motor drive and indicate the advantage gained through elimination of belts.

# The 1910 Edison Storage Battery

By WALTER E. HOLLAND

*(Concluded from the February Issue)*

So far, it has been determined that, in general, the cooler a battery is kept the longer will be its life; and that heat during charge is more detrimental than heat during discharge. As regards immediate output, the highest results are obtained by charging cool—say at a cell temperature of 75 to 85 degrees Fahrenheit—and discharging hot, that is, at 120 to 130 degrees cell temperature. The output will be reduced if charging is done at a cell temperature of less than 50 degrees F. or more than 105 degrees F., or if a battery is cooled to a low temperature during discharge. The Edison battery appears to be affected by low temperatures in about the same degree as the lead battery, and the sal-

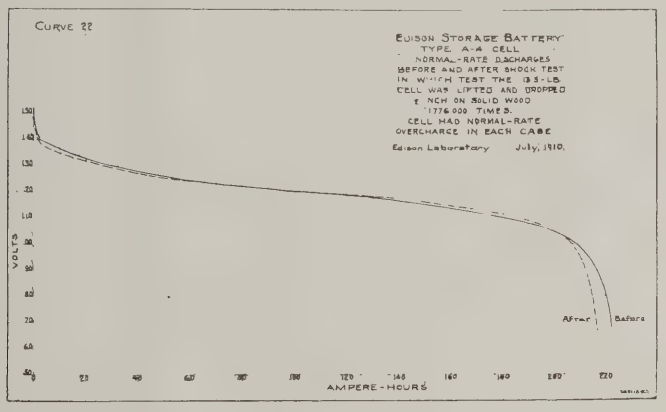



Fig. 17.—Discharge Curve After Shock Test.

vation of both in cold weather lies in the fact that they are self-warming. It is a providential arrangement that the internal resistance of a cell becomes greater as the temperature decreases because on this account the generation of heat within a battery is greatest when the battery is cold and automatically decreases as its temperature rises.

An interesting but not at all surprising character-

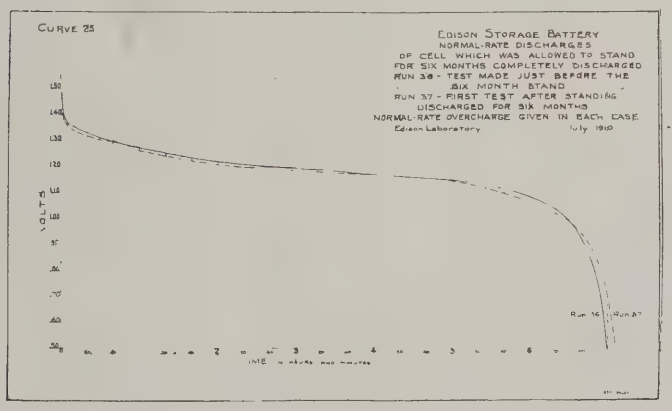

CURVE 23
EDISON STORAGE BATTERY
NORMAL-RATE DISCHARGES
OF CELL WHICH WAS ALLOWED TO STAND
FOR SIX MONTHS COMPLETELY DISCHARGED
RUN 38 - TEST MADE JUST BEFORE THE
SIX MONTH STAND
RUN 37 - FIRST TEST AFTER STANDING
DISCHARGED FOR SIX MONTHS
NORMAL-RATE OVERCHARGE GIVEN IN EACH CASE
Edison Laboratory July 1910
VOLTS
Run 38
Run 37

Fig. 18.—Discharge Curve After Standing Discharged Six Months.

istic of the Edison battery, which probably is common to storage batteries in general, is the fact that the rate of loss of charge during idleness varies with the temperature at which it stands, the loss being slight in the cold and greater as the temperature increases.

The sturdiness of the Edison battery has often been summed up in the statement that it is "fool-proof." And so it is,—but there are idiots! Therefore the company does not give prominence to this feature, but rather insists on careful handling of the battery at all times. Nevertheless, we have made many "fool" tests for our own satisfaction, and there can be no harm in showing the results of some of these to sensible men.

### Endurance of Abuse.

Fig. 17 shows the indifferent effect on a cell's electrical characteristics of a severe mechanical shock treatment.

The damage done to lead cells by sulphation through standing wholly or partially discharged is well known, and when such a battery must remain out of commission for some time it is necessary either to give it freshening charges at frequent intervals, or else to give it a complicated shelving treatment involving much labor and trouble. The Edison battery can be set aside and forgotten in any state of charge or discharge for a practically unlimited length of time without fear of injury. Fig. 18 shows comparative discharge of a cell before and immediately after it had stood six months in a totally discharged condition.

Fig. 19 is an interesting curve showing the alacrity with which the Edison cell adjusts its voltage to sudden changes of discharge rate; and showing also how nearly

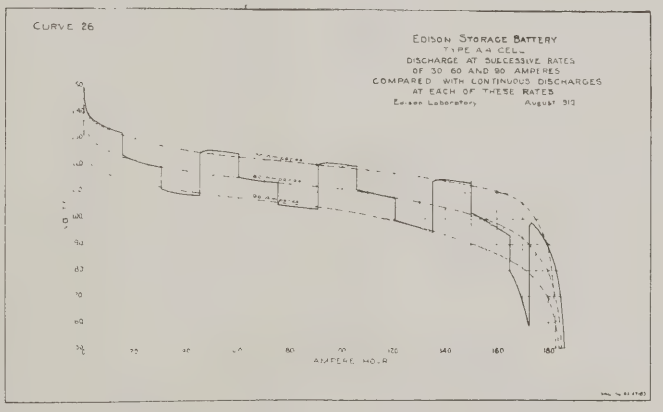



Fig. 19.—Discharge at Successive Rates.

the voltage at different rates corresponds to that of constant-current discharges at each rate. The slight disagreement between these voltage values is accounted for by variations of internal resistance due to temperature differences. The dropping off at the highest rate toward the end of the varied-rate discharge seems to indicate that it is the increased heating alone which causes full capacity to be given at the same high rate of constant current.

### Life.

The duration of usefulness of the new-type Edison battery must still remain a conjecture, sufficient time not having yet elapsed since its inception to ascertain this by actual service tests. Life tests have been made in the laboratory, however, under conditions designed to accelerate deterioration; and by comparison and inference some sort of an estimate can be formed from the results of these.

To get life results more quickly use is made of two

principles, one—mentioned previously under "Normal Ratings"—that high-temperature working shortens life; the other, that discharging to zero voltage, if practiced continualy, has a similar effect.

All ideas as to improvement of the storage battery are first tried out in miniature cells having the single iron pocket and single nickel tube (1-24 and 1-30 parts, respectively, of regular plates) as electrode units. These experimental cells are just like the commercial cells in mechanical construction and give comparative results at proportional rates. A relatively quick life-test is obtained by maintaining such cells at a temperature of 130 degrees F. during both charge and discharge, and carrying every discharge to zero voltage. After every fifty such "hot runs" each group of cells is allowed to cool down, and is then tested at normal temperature. It is certain that this "killing test" is at least three and perhaps five times as severe as the conditions of commercial service; that is, 50 hot runs would be equivalent in effect to 150 to 250 runs in practice. Nevertheless, miniature regular cells will increase in capacity during 150 to 200 hot runs, and at the end of 500 hot runs will usually have better than original capacity. In some cases after 1,000 hot runs, cells had lost only 20 per cent of their original capacity.

Life tests of many "A4" cells are also made, but at somewhat lower temperatures, as it is desired to have the conditions approach a little nearer the normal. In this case the temperature averages only 105 to110 degs. F., but every discharge is carried to zero voltage, each cell then being short-circuited some minutes to ensure its complete discharge. The severity of this test as

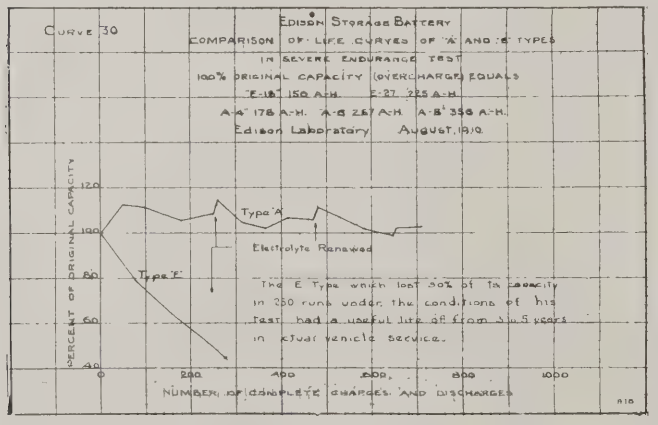



Fig. 20.—Life Curves of "A" and "E" Types.

compared to service conditions can be judged from data obtained on the "E" type of Edison cell, some batteries of which were put in commercial operation six years ago. Curve "E" of Fig. 30 shows that this old type lost 50 per cent capacity in 250 runs under the conditions of this test, and yet in actual vehicle service it proved to have a useful life of three to five years. Curve "A" of Fig. 20 is the life result to date of the "A" type under the same adverse conditions. The inconstancy of the output in this case comes principally from differences of temperature, as the tests were made in a top-story room whose temperature varied considerably, depending upon outside conditions.

---

Burton W. Mudge & Company, railroad supplies, Chicago, have added materially to their well equipped organization by electing Thomas H. Garland a vice-president. The attention of Mr. Garland will be directed to the development of car ventilating and refrigerating devices, patented by him while superintendent of refrigerator service of the Burlington System.

## ELECTRICAL EQUIPMENT OF ROYAL TRAIN ON SOUTH AFRICAN RAILWAYS.

The Royal Train, comprising ten cars, which was placed at the disposal of the Duke and Duchess of Connaught during their recent tour in South Africa, was constructed at the Railway Workshops, Pretoria, Transvaal.

The total length of the ten cars was 624 feet and the total weight 727,600 lbs., or 363.8 short tons.

The whole of the carriages were fitted with Stone's Electric Lighting and Ventilating Installation, the total number of lamps on the train amounting to 375, the electric fans numbering 24, the dining car being fitted with a power exhaust fan to remove any smell of cooking from the kitchen.

The equipment of the Royal saloons consisted of 44 electric lamps, tastefully arranged in electroliers and brackets of elaborate design plated with mercurial gilt and so oxidized to blend with the interior decorations, the shades being of maize colored silk of a tulip shape.

Electric tail and side lights were provided, likewise a commodious dark room fitted with ruby electric lamps, and fans. A thorough system of bell communication, with indicators, was arranged so that the occupants of the Royal saloons were in communication with the maids, valets, or footmen, and the indicators were so arranged to point out at a glance who was required and which compartment to go to.

The various accessories fitted in connection with the electrical equipment were electric shaving water heaters, curling tong heaters, and cigar lighters, and a vacuum cleaner, all of which derived their current from the train lighting apparatus.

The Royal train was also equipped with a complete system of telephones, telegraphic apparatus and phonophores, so that the Royal party were in constant touch with the outside world in case of urgent news.

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## CAN YOU SPARE THESE COPIES?

The fact that we are all out of copies of the "Railway Electrical Engineer" for August, October and November, 1910, is an excellent indication of the popularity of the paper, and as such is naturally very pleasing to us. But in order to complete our files we want to get hold of some of them. If you can spare them we will pay 25 cents each for a limited number of copies of these issues. If you will send us one of each we will extend your subscription 10 months.

---

Mr. W. S. Taussig has been transferred from the Chicago office of the General Electric Company to the office of the General Electric Company of Texas, at Dallas. As in charge of power machinery sales, Mr. Taussig has been in close touch with many of the railway electrical men in and about Chicago, who will greatly regret his departure. His place in Chicago will be filled by Mr. A. I. Totten, who has formerly been engaged in similar work for the General Electric Company in the eastern states.

---

Dr. Frederick H. Millener, who has for the past two years been conducting an experimental investigation of the possibilities of wireless telegraphy delivered a lecture before the New York Railway Club on Feb. 17. The title of Dr. Millener's address was "The Application of Wireless as an Adjunct in Operation of Railroads." Some details of the results of the experiments will be published in the April issue of the Railway Electrical Engineer.

# The Dope Sheet

## STEAM RAILWAY ELECTRIFICATIONS.

### ST. CLAIR TUNNEL.

ST. CLAIR TUNNEL ELECTRIFICATION, 25 CYCLE, SINGLE PHASE SYSTEM OPERATING AT 3,300 VOLTS*

**General:**

| | |
|---|---|
| Length of electrified zone | 3.66 miles. |
| Length of electrified single track. | 12 " |
| Length of tunnel in feet. | 6,032 |
| Maximum grade | 2% |
| Normal weight of trains | 1,000 tons. |

**Locomotives,** each consisting of two similar half units:

| | |
|---|---|
| Number of half units | 6 |
| Length over all of half unit | 23 ft. 6 in. |
| Height from top of rail to top of roof | 13 ft. |
| Width of cab over all | 9 ft. 8 in. |

**Locomotives**—Cont'd.

| | |
|---|---|
| Weight of half unit, fully equipped | 67.5 tons. |
| Number of pairs of drivers per half unit | 3 |
| Diameter of driving wheels | 62 in. |
| Length of rigid wheel base | 10 ft. |
| Normal motor capacity of half unit | 750 h. p. |
| Normal draw bar pull | 50,000 lbs. |
| Normal speed on level track | 25 to 30 m.p.hr. |
| Normal speed up 2% grade with 1,000 ton train | 10 m. p. hr. |

**Working Conductor:**
Single catenary, supported on structural steel bridges.

**Power Plant:**
Coal and ash handling equipment: Bucket elevator; belt conveyor; bunker capacity.....750 tons
Boilers: Four 400 h. p. water tube; working pressure.....200 lbs.
Stokers: Automatic underfeed with forced draft.
Superheaters: One 2,000 h. p.—separately fired.
Turbo-generators: Two 1,250 kw. 25 cycle, 3,300 volt, 3 phase generators with full rating as single phase machines, driven by Westinghouse steam turbines.
Condensers: Two 30-in. barometric jet condensers, with steam driven centrifugal circulating and rotative dry vacuum pumps.
*Compiled from Grand Trunk Railway System booklet.

### SINGLE PHASE.

SINGLE PHASE ELECTRIFICATIONS ON STEAM RAILWAYS AND IN TRUNK LINE SERVICE *

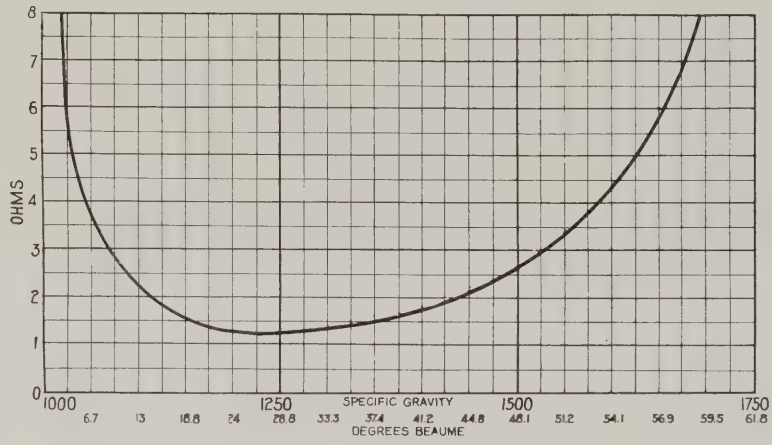
| ROADS | Miles of Line | Miles of Single Track | Line Voltage | Motor Cars No. | Motor Cars hp. | Locomotives No. | Locomotives hp. |
|---|---|---|---|---|---|---|---|
| N. Y., N. H. & H. R. R., Main Line | 21 | 100 | 11,000 | 4 | 600 | 41<br>2 | 1,400<br>1,600 |
| New Canaan Br. | 8 | 8 | 11,000 | 2 | 500 | | |
| Grand Trunk R. R. | 3.5 | 12 | 3,300 | | | 6 | 900 |
| Erie R. R., Rochester Div. | 34 | 34 | 11,000 | 6 | 400 | | |
| Colorado Southern Ry., Denver & Interurban | 46 | 46 | 11,000 | 8 | 500 | | |
| Baltimore & Annapolis Short Line | 25 | 30 | 6,600 | 12 | 400 | | |
| Swedish State Rys. | 7 | 7 | 3,300<br>20,000 | 2 | 240 | 1 | 300 |
| Midland Ry., England | 8.5 | 17 | 6,600 | 1<br>2 | 300<br>360 | | |
| Prussian State Rys. | 16.5 | 31 | 6,600 | 20<br>42<br>54 | 250<br>400<br>345 | 1 | 1,500 |
| London, Brighton & South Coast Ry. | 8.6 | 17.2 | 6,000 | 16 | 460 | | |
| Rotterdam-Haag-Scheveningen | 20.5 | 46.5 | 10,000 | 19 | 360 | | |
| Spokane & Inland | 129 | 129 | 6,600 | 28 | 400 | 6<br>5 | 500<br>720 |
| Midi Ry. of France | 75 | ..... | 12,000 | 30 | 500 | 2 | 1,600 |

*From paper by Geo. Westinghouse before joint meeting of A. I. E. E. and A. S. M. E., London, July, 1910.

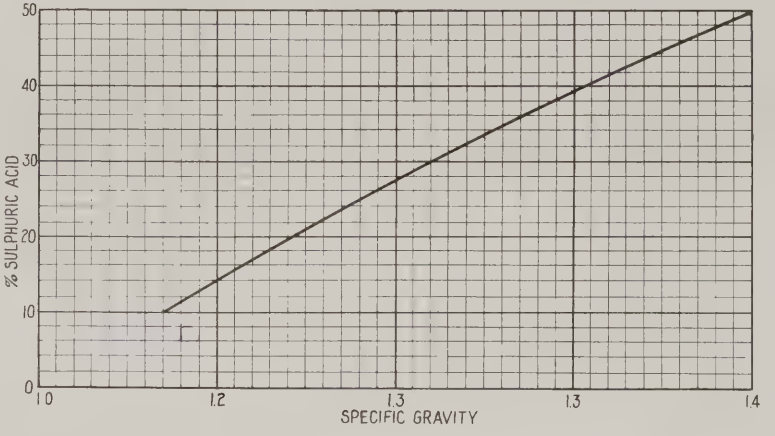
## STORAGE BATTERIES.

### SULPHURIC ACID ELECTROLYTE.

VARIATION OF INTERNAL RESISTANCE WITH SPECIFIC GRAVITY.




VARIATION OF SPECIFIC GRAVITY WITH PERCENTAGE OF ACID.



# General News and Personal Mention

## USE OF STREET CAR WATTHOUR METERS.

As a guard against waste due to carelessness of motormen in the operation of controllers, as a check upon motor efficiency and general car operation, the watthour meter's usefulness has been generally recognized.

It has been claimed by good authorities that the difference in K. W. H. used by different motormen on the same line and running the same equipment would vary from five to thirty per cent. Knowing that power is being wasted, the first step is to call attention to this waste by installing meters which will give an absolute record not only of the day's, week's or month's consumption—but also the consumption per trip. With this information steps can then be taken to educate

Street Car Watthour Meter

those men who are improperly operating cars. Aside from establishing a basis to instruct the mtormen as to the proper operation of individual equipments, with watthour meters installed on every car on a particular line or system, the total kilowatt-hours used would thus check against the station output, the difference between the totals being in transmission loss, leakage, etc. This is analogous to the comparison obtained between the total readings of the consumers' meters in electric lighting service with the station output meters, and it has been found in such service that this comparison often affords the most accurate, and really the only method of picking out and hunting down undue losses in transmission, etc.

Even with a few meters, shifted at intervals of a week or so from one car to another of a line, a series of readings could be obtained during the course of a few months, which would give a fairly good check of total car consumption against station output. This method might be practically as satisfactory, and considerably less expensive, to a railway company desiring to investigate the matter, as installing meters on all cars.

The Sangamo Electric Company of Springfield, Illinois, placed on the market the meter illustrated herewith, after making exhaustive tests in regard to the amount of jarring, pounding and vibration which the mercury floated meter system would withstand.

During the past two years the Mercury Flotation Type Meter has been in continuous service on electrically lighted steam railroad cars on practically every large railroad system in the United States. The meters have withstood the rough usage, jars, shocks, etc., without the slightest injury.

In general, the mercury meter consists essentially of a disk-like motor element partly or entirely submerged in mercury, so that a current can be led in and out from this element by the mercury through fixed metallic contacts set in the walls of the chamber containing the mercury and disk. The reaction of current passing radially or diametrically across the armature—that is, the metallic rotating element—with a magnetic field properly set with respect to the armature, will cause rotation, and this rotation will be proportional to the amount of current passing through the armature.

---

Gill Selectors in Telephone Train Dispatching are described in Bulletin 501 just issued by the United States Electric Company of New York and Chicago. Telephone dispatching has been so rapidly adopted on the railways of the United States that it may not be surprising to learn that although the first installation was put in service less than four years ago, more than 35,000 miles of line are now worked by this system. The Bulletin describes the development of the selective calling system particularly in its application to railway telephony and explains fully the functions and service of the Gill Selector and the answer-back. The selector is bridged directly across the telephone circuit and operated without the use of relays or local battery at the stations. The circuits and the outfits, for calling with the local battery bell and the main line bell are described and illustrated and some facts regarding the economic advantages of substituting selective telephone train dispatching for the telegraph sounder call are rather convincingly assembled.

---

J. H. Cooke, manager of the Chicago office of the Buckeye Electric Company, is expected to return soon to Chicago. He has just recovered from a long siege of illness which forced him to spend some weeks at Hot Springs, Arkansas. D. H. Wyre, assistant manager, has been in charge of the Chicago office during Mr. Cooke's absence.

---

The Moloney Electric Company of St. Louis has recently secured a contract from a Canadian electric railway for $268,000 of transformers. To handle this and other Canadian business the company has established a branch factory at Windsor, Ontario.

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In the mention of the Refillable Fuse Shell made by the Daum Manufacturing Company of Pittsburgh last month in these columns, the statement that this article is patented was unfortunately omitted. This error is now rectified.

---

The Wagner Electric Mfg. Company of St. Louis is making some improvements in their Portable Testing Set for train lighting. It is expected that the improved instrument will be placed on the market in the near future.

---

The Electrical Engineers Equipment Company is distributing a new catalog containing some interesting data.

# "National" STORAGE BATTERIES

THE STANDARD BATTERY FOR CAR LIGHTING SERVICE

ANY CAPACITY
ANY TYPE
ANY METHOD
OF ASSEMBLY

C. L. A.—15 ASSEMBLED IN TWO-COMPARTMENT LEAD-LINED TANK

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## ELECTRIC TRAIN LIGHTING

## ECONOMY RELIABILITY EFFICIENCY

These three all-important considerations are thoroughly demonstrated in the **"Bliss"** and **"Moskowitz"** Systems of Electric Car Lighting. Actual figures obtained from operating conditions on a large number of railroads indicate conclusively the superior advantages of these two Systems over all others.

PERFECT REGULATION and LOWEST OPERATION COSTS are assured to the purchaser.

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**General Office: 30 Church St., New York**

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**NEW YORK CHICAGO BUFFALO CLEVELAND DETROIT ST. LOUIS BOSTON SAN FRANCISCO**

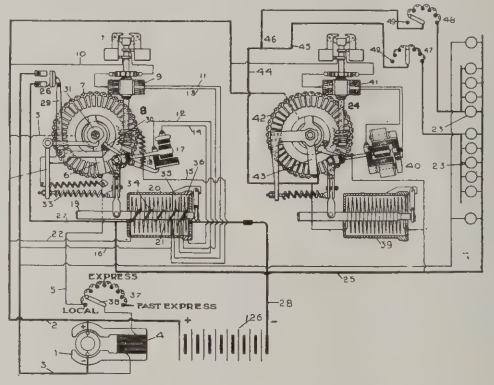
## U. S. LIGHT & HEATING COMPANY'S NEW REGULATOR.

Patent No. 978,388 on Electric Lighting Apparatus was issued to James F. McElroy, assignor to U. S. Light & Heating Company, on Dec. 13, 1910. This patent covers certain improvements in the regulating device, which are explained by the inventor as follows:

These improvements may be described as a means for varying the point in speed at which the generator cuts in or out of operation. I have made use of an automatic switch controlled by the generator potential and adapted to close when the voltage of the dynamo has reached a predetermined point. Heretofore this switch has always closed at the same train speed, say 20 miles an hour, and opened when this speed has been reached in slowing down. If the regulator were out of adjustment this might sometimes result in overcharging the battery in a long daylight run, while a car given a night run with frequent stops might have its battery undercharged.

To remedy such a condition and also to adapt the car-lighting system more fully to different services, the present invention provides for connecting and disconnecting the generator with the lamps and battery at a plurality of speeds, the apparatus being adjustable to determine in advance the speed at which the generator shall cut in. This enables the generator to cut in at a lower speed on local or relatively-slow service and at a higher speed on fast service, and adapts the car for performing all services in the most economical manner.

It is evident that if the generator cuts in at a speed of 35 miles an hour instead of 20 miles, the car lamps will tend to run for a longer time on the battery and for a shorter time on the generator in any given run. The additional apparatus necessary to effect this result is of a very simple nature and may consist of a manually-adjusted resistance or hand-rheostat in the generator shunt-field, which also contains the automatically-variable resistance in the generator regulator. Inasmuch as the voltage of the generator depends upon the amount of current flowing through the shunt-field, and the potential magnet controlling the cut-in switch is set to operate at a fixed voltage, it follows that by manually changing the resistance of the shunt field I am enabled to increase or decrease the voltage resulting from a given speed and hence either postpone or advance the time of closing the cut-in switch. When the generator finally cuts in at the standard voltage, it charges the battery at the usual rate irrespective of the adjustment of the hand-rheostat. In other words the rate of battery charging is controlled by the automatic generator regulator, and the hand resistance takes effect before the automatic regulator comes into operation.




# Association Directory.

### ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....323 Kinzie St., Chicago.**

The next convention of the Association will be held in Washington, D. C., in the first week of June, 1911. The Annual Convention will be held in Chicago in the second week of November, 1911.

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The Rust-Proof, Non-Corrosive Conduit

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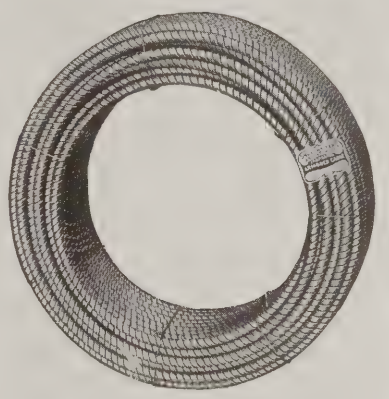

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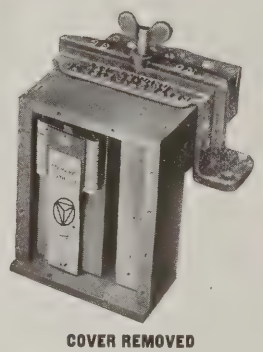

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**Indispensable to First-Class Train Lighting**

**Fool Proof**

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are easily attached to machine tools or any other forms of machinery.

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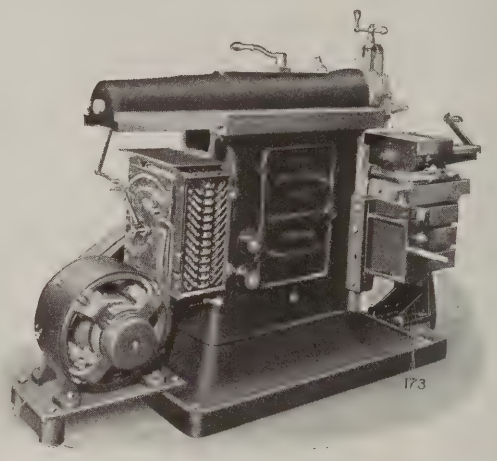

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# The Edison Storage Battery for railway train lighting

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**EVERY EQUIPMENT GUARANTEED.**

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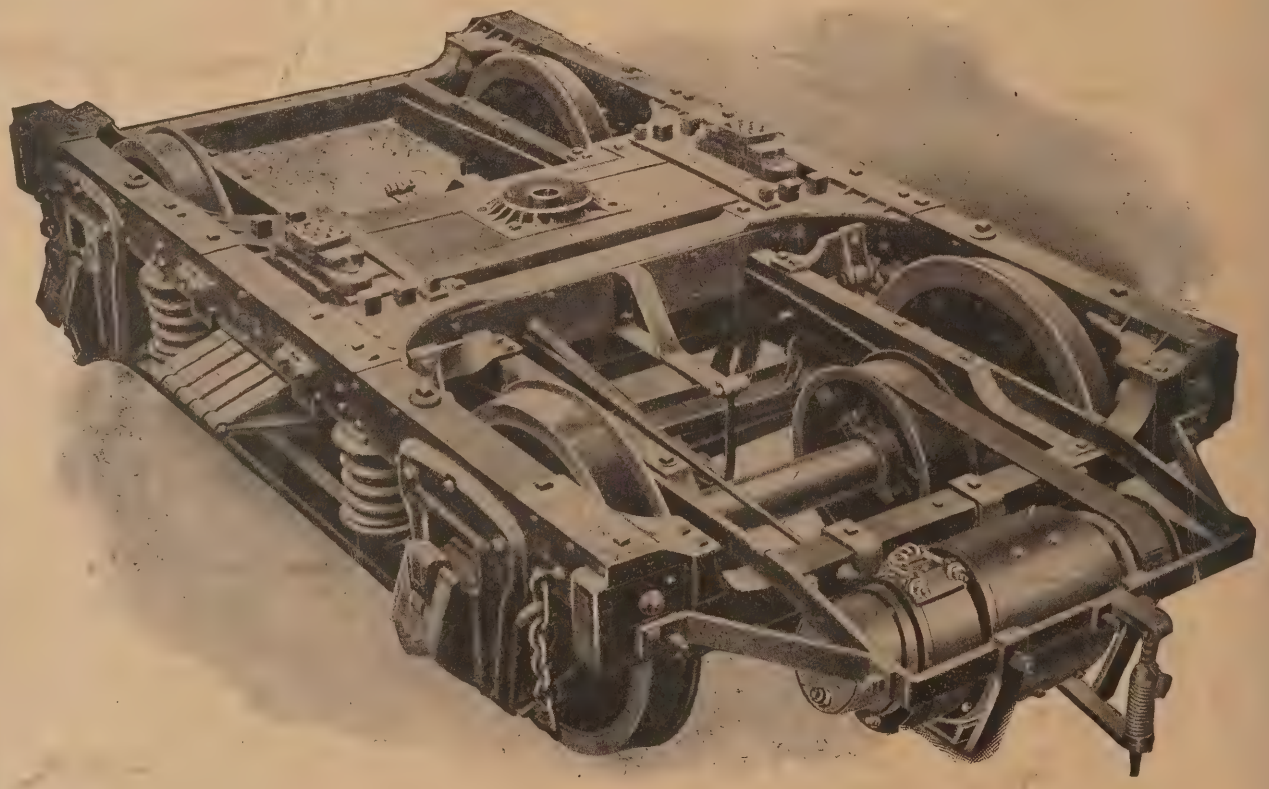

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WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

The Official Journal of the Association of Railway Electrical Engineers

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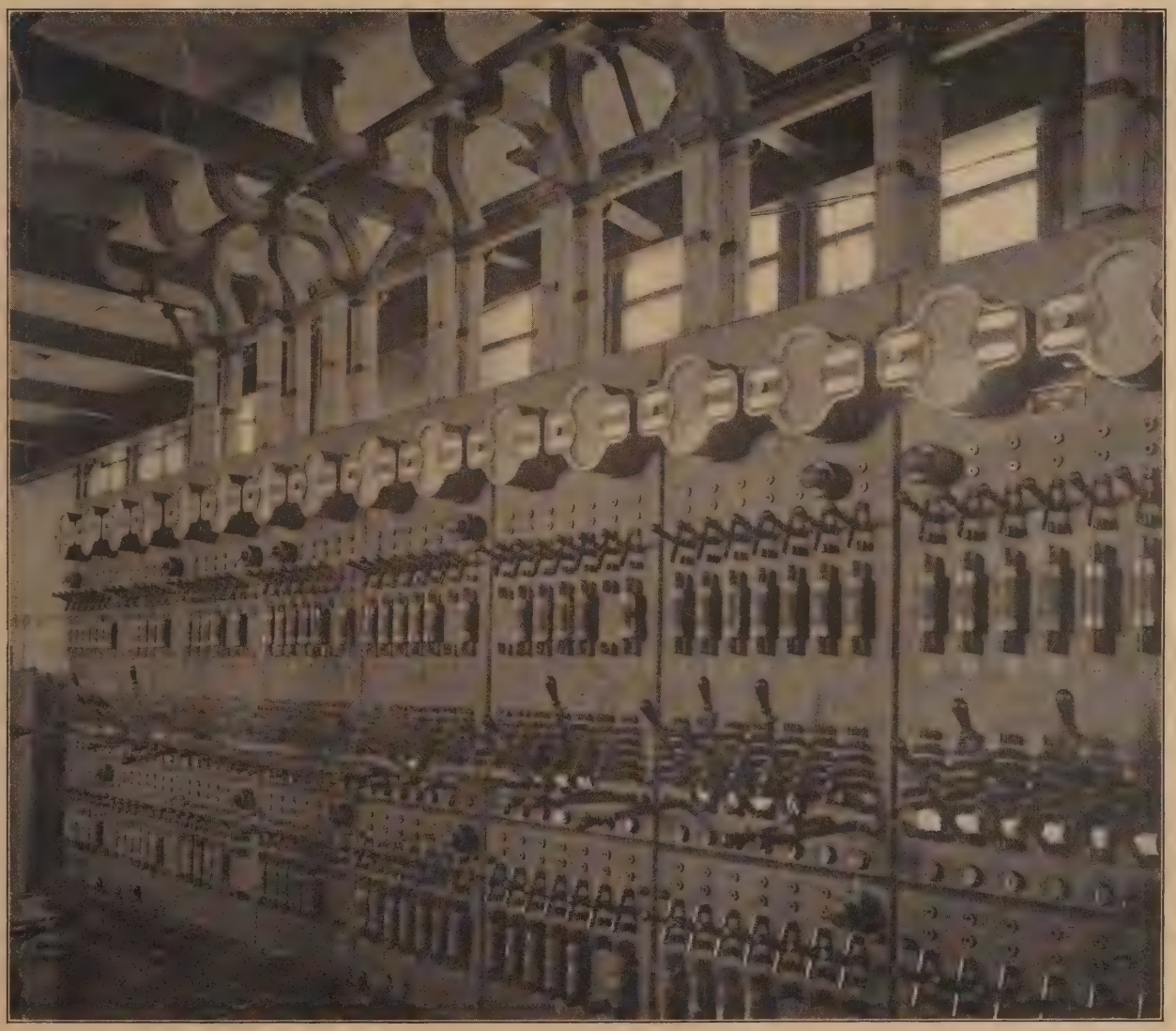

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**Kerite Insulated Wire & Cable Company**

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Western Representative: Watson Insulated Wire Company, Railway Exchange Building, Chicago, Ill.

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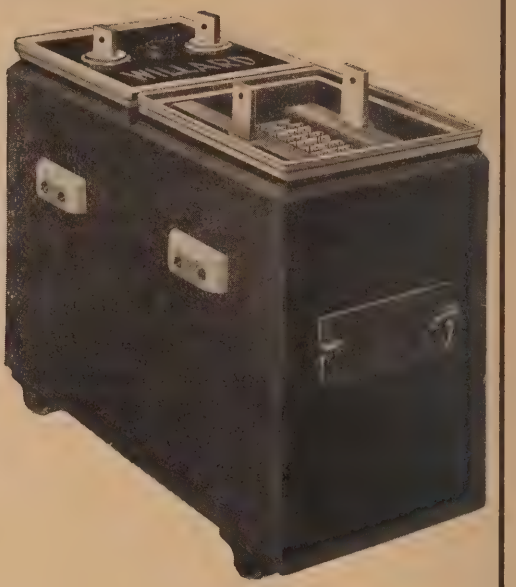

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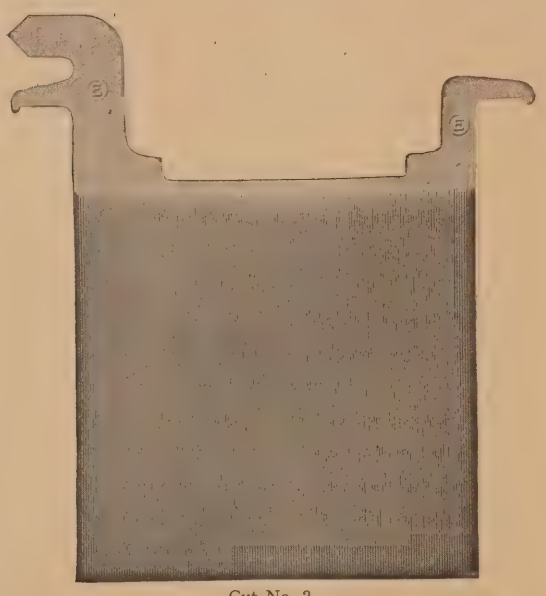

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Conforms in every detail to Signal Association's Standard

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## Construction

Absolute uniformity in the thickness of raised portions gives a perfectly even distribution of current over all the surface of the plate.

Correct proportioning of active surface.

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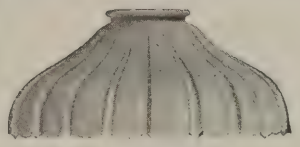

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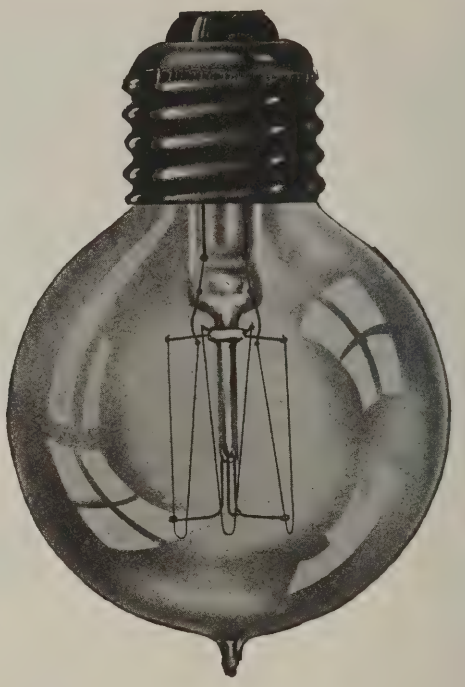
LAMP



embodies all the highest qualities to be found in any lamp. It is the result of a most careful study into the train lighting proposition and has been carefully designed to meet the special requirements of this service.

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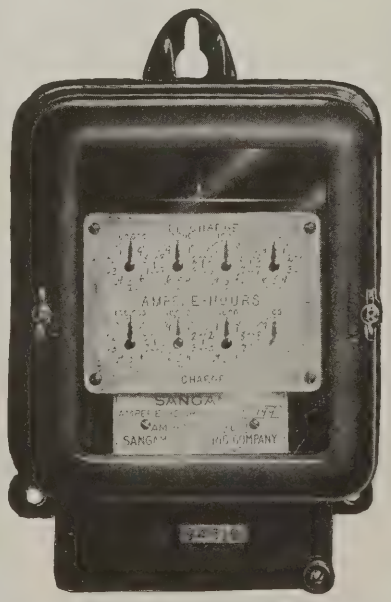
# Ampere Hour Meters for Storage Battery



## equipment will increase the life of the battery and provide an absolute check on the entire equipment

When applied to the operation of straight storage equipment the saving in current effected by the meter over that required when charging by the gravity method, will pay for the meter in three months.

In connection with Head End or Axle Lighting Equipment, the *Duplex Train Meter* provides an absolute check on the operation of the equipment, ensuring proper charging of the storage battery, and more reliable operation of the whole equipment. It will show you exactly how much the storage battery is being overcharged or undercharged.

**Do You Know How And Where To Use Them?**

**SANGAMO ELECTRIC COMPANY**

**Springfield, Illinois**

What you want from an electric lighting equipment is

# Light

You want light *in sufficient quantity* and *of proper quality.*

You want this light *when you want it* and *where you want it.*

You want this light supplied at a *minimum cost* of labor, material and depreciation.

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We are furnishing a *complete electric system* from the generator to the lamps.

We furnish a generator of *ample capacity for all the light you want.*

It is *ready when you want it.*

Our fixtures distribute the *light where you want it.*

---

The careful consideration of each and every component part and operation in its relation to the *efficiency of the system as a whole* is the foundation principle in the design and manufacture of our electric equipment.

This system is known as our *B. C. S.*

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*The generator* has the *latest improved suspension,* is *positively dust-proof, easily accessible* and has *ample capacity for all service.* The oiling device is positive, providing *ample lubrication,* the *pole changer is automatic* and simple and the armature is designed according to latest improved practice with form wound coils.

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*The lamp regulator* keeps the *voltage constant on any number of lamps,* from one to the full number in your equipment, by a variable carbon resistance in series with the lamps.

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All necessary connections and resistance units are located on the *front of the regulator boards and easily accessible.*

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**Railway Electrical Engineer**

will be strongly in evidence at both. Better reserve space now.

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It contains, each month, 28 sheets of up-to-date engineering information. You detach each sheet and place it in your alphabetical file where it is instantly available whenever you wish. We would like to send you a sample copy.

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(Patented)

**For Railway Car Electric Lighting**

While this pulley is made to meet the special demands of electric car lighting, its general principles are not different from the **World-famous** "American" Belt Pulley.

It has been pronounced by experts the best of its kind. This is but natural as it is the "first cousin" to the "American" Wrought Steel Pulley.

It is a parting pulley:—light, strong, easily put on or taken off, indestructible, accident proof.

Write for more explicit information. We will cheerfully send you our complete catalog showing the full line of our standard belt pulleys. Made in sizes 6 inch to 60 inch diameter: 2 inch to 36 inch face. Also made in sizes intermediate to those listed.

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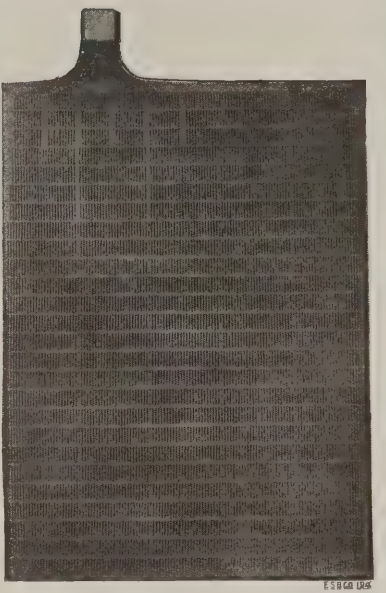
2. The distinctive feature of through and through circulation of electrolyte.
3. Re-inforced features made possibe by its type of construction.
4. A large amount of reserve lead in the ribs.
5. A plate structure such as to give strength, to minimize growth and buckling and to decrease sediment.

Railway electrical engineers will appreciate that these features of the "Tudor" positive plate are such as will give long life.



The "Tudor" Positive Plate

Engineers interested in car lighting will find "Catalog C," a copy of which can be procured from any of the Sales Offices, to contain useful information

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is commonly supposed to be the only function of a fan. However important this function may be, it is not the only thing that a fan should do.

When installed in the ceiling of a car

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draws in a steady stream of pure, fresh air and distributes it equably throughout the body of the car. Ventilation is perfect and positive at all times and is independent of the speed of the train or outside atmospheric conditions.

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**Co-operation** along technical and commercial lines.

**Progress** in the support of an Engineering Department equipped with research and development Laboratories

**Quality** in expert supervision and testing of the product of each of the factories of the member companies.

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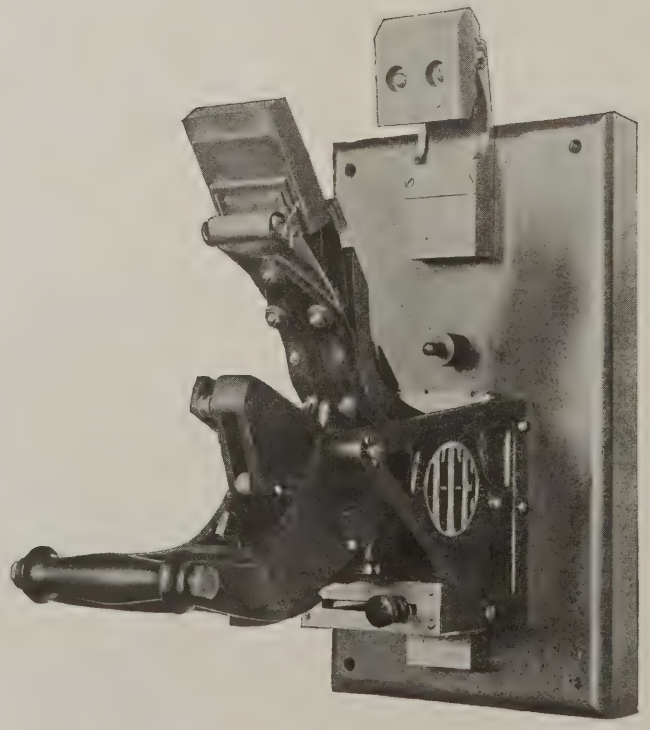

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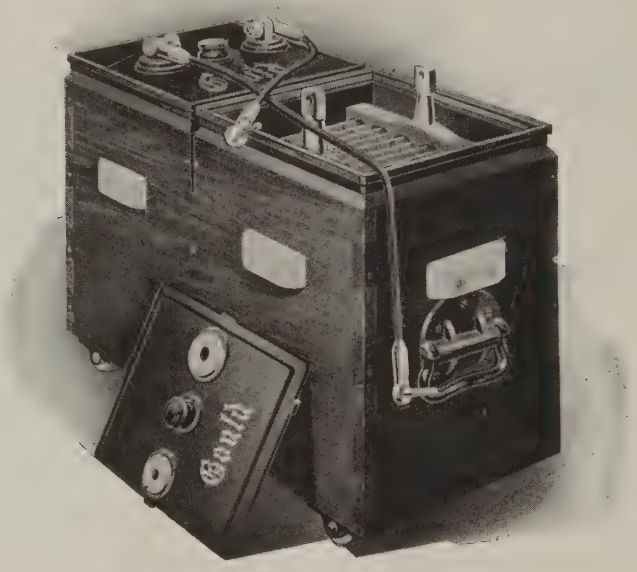


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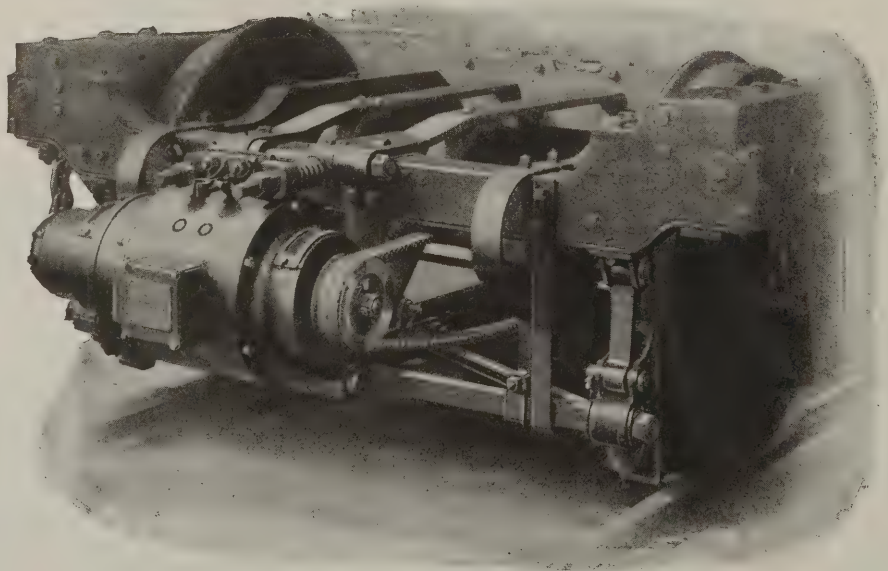

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# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

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EDWARD WRAY, President. J. G. WRAY, Sec. & Treas.

RALPH BIRCHARD, Manager.

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CHICAGO

Telephone Main 2457.

NEW YORK OFFICE, Flatiron Building.

Editors ..... Edward Wray, C. L. de Muralt, Geo. W. Cravens, Ralph Birchard

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

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TERMS OF SUBSCRIPTION

United States, Canada and Mexico . . . Per Year, $1.00


OUR OBJECT.

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


EDITORIALS—
- The Telephone Number ..... 223
- A Standard of Illumination ..... 223
- Shop Section—Announcement ..... 223

Association News ..... 224
Car Lighting Club ..... 224
The Selector in Railway Telephone Service ..... 225
Extent of Telephone Train Dispatching ..... 227
Wireless on the Railways ..... 228
The Prentice System of Train Control ..... 228
Wireless Experiments on the Union Pacific ..... 229
Wireless in Railway Service ..... 230
Telephone Selector Resistances ..... 231
An Electric Railway's Telephone Equipment ..... 231

ELECTRIC TRACTION SECTION—
- Single Phase Locomotive for Loetschberg Railway ..... 233
- Storage Battery Cars for Branch Lines ..... 235

SHOP SECTION—
- Practical Operation of D. C. Motors ..... 236
- Boring Mill Drive ..... 237

The Dope Sheet ..... 238
General News and Personal Mention ..... 14
Boiler Scale Prevention by Electricity ..... 16
Association Directory ..... 16


### The Telephone Number.

IN Nebraska at one time there was a bill prepared for the legislature forbidding the use of telephones for train dispatching. The bill was supposed to have been inspired by the telegraphers' union. It never became a law for obvious reasons.

The contention of the telegraphers was that the introduction of the telephone put them out of work and tended to lower wages. The first objection is much the same as would be that of a snow shoveler objecting to the use of a snow plow. Foolish as it may seem it is an objection that has been put in the way of nearly every inventive improvement ever made. As a matter of fact the telephone does not lower wages. That the ability to send and receive the Morse code should constitute a man a skilled workman is manifestly absurd. The qualities required in a good station operator make this mere mechanical accomplishment so unimportant that the ambitious man should be glad to see it stricken from the list.

Anyhow, regardless of the changes it may cause in the personel of the railway operating force or the hardships it may cause in a few exceptional cases, the telephone for train dispatching has come to stay. And it is with this thought, and with the idea of making clear why it has come to stay that this issue of the RAILWAY ELECTRICAL ENGINEER has been made a Telephone Number.

### A Standard of Illumination.

Recent speakers on the subject of car illumination in general and railway car illumination in particular have emphasized the need of having some definite standard of good illumination towards which the designers of lighting systems could work. The need is real enough. All progress is made by first finding out what is wanted and then taking steps to get it. But when it comes to finding out just what illumination is wanted the engineer is confronted by a difficult problem by reason of two variables in the equation. These are (1) color of car furnishings which causes variation in general brightness and (2) individual taste which causes one man to find inadequate and condemn lighting which another man will find ample and praise. In spite of these difficulties it ought to be possible to find what amount of illumination best suits the average man. The selection and general adoption of a standard amount would not only greatly aid the work of the car lighting engineer, but it would educate the traveling public to a common standard which would meet with general approval.

### Shop Section—Announcement.

IT is safe to say that very few engineers fully understand the development which has taken place in railway shop design. Not but what enough has been said and written on the subject. Every shop in the country has at some time or other been described in one or more of the technical journals. The trouble is that these descriptions have been scattered and occasional, so that it has been impossible to get from them a broad general view of the whole shop situation and the reasons for the changes in design.

Although there are comparatively few men who fully understand the shop situation we believe there are many who would like to do so and for this reason we have planned our Shop Section as follows:

Ten of the largest and most typical railway shops equipped with motor drive will be described. These descriptions will appear in chronological order—that is, the shops will be described in the order in which they were installed. Each description will follow the same definite outline so that comparisons between them may be made at a glance. The last article of the series, appearing in March, 1912, will summarize all that may be learned from a careful study of the particular cases and show not only what changes have taken place in shop design, but also why they have taken place.

We feel sure that no series of articles could be of more interest to those in charge of railway shop operation than this will be. The series will begin in the May issue.

## ASSOCIATION NEWS.

**This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.**

**It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.**

### CONVENTION DATES.

A slight change has been made in the dates for the June Convention. The dates will be June 16 and 17 instead of June 15 and 16 as announced last month in these columns.

The Annual Convention will open with a reception Monday evening, November 6th, and will continue from the 7th to 10th inclusive. The entire nineteenth floor has been reserved for the convention. The exhibits will occupy the large ball room, and the meetings will be held in the Red Room, which the members will recall as having been the scene of the banquet at the last three conventions.

### EXECUTIVE COMMITTEE MEETING.

The Executive Committee met in Chicago March 1st at the Great Northern Hotel. Reports of progress by the different committes were received and a number of applications for membership passed upon.

The Committee on Illumination met March 15 at the Chicago Press Club. There was a full attendance and considerable progress was made.

### CAR LIGHTING CLUB.

The March meeting of the Car Lighting Club, held Wednesday evening, March 15th, was the best attended in the history of that organization, due largely to the efforts of two men, Geo. B. Colegrove and H. G. Myers, who made a personal canvass of the car lighting men in the Chicago yards in the two weeks preceding. Over 80 men were present.

The club was disappointed in not hearing the address of Mr. Chamberlain, who was unable to be present, but this gave opportunity for several interesting talks by other speakers.

Mr. Geo. H. Stickney read parts of a paper presented before the New York Section of the Illuminating Engineering Society on "The Allegheny County Soldiers' Memorial." He said that the illuminating effects secured in this building by judicious use of many different light sources of various colors had opened up a new world of possibilities in decorative lighting.

Mr. A. J. Sweet, who is engaged in special research work in railroad lighting for the Holophane Company, pointed out the difficulty of fixing a standard for good illumination. In an absolutely black room ¼ candle-foot on the reading page has been found to be amply sufficient. As the surrounding light increases the light requirement increases till some rooms require as much as 5 or 6 candle-feet.

There are two factors in lighting:

1. Intensity of illumination.
2. Efficiency of perceiving apparatus, the eye.

The problem is how to make the eye most efficient. This is accomplished when each object is illuminated to the minimum intensity required. Any excess over this amount lowers the efficiency of the eye and is a positive evil.

The word "glare" is used in two entirely different senses. First, to mean the unpleasant effect of a brilliant light source, and second, to mean the lowering of eye efficiency. The first effect is produced only by light sources within an angle of 25 degrees from the line of vision.

J. R. Cravath made some general remarks on illumination, saying that the rather slow progress of the art of illuminating engineering on the railroads was probably due more to a lack of appreciation on the part of the public than to a lack of knowledge on the part of the men in charge.

After the speechmaking was over an informal mixer was held. It was decided to hold the meetings of the club hereafter regularly on the third Wednesday of every month. The place of meeting will be the Chicago Press Club on Dearborn street, between Madison and Washington.

The next meeting will be held April 19th. The subject for discussion is "The Cost of Car Lighting and How it Should Be Figured." Mr. D. J. Cartwright is scheduled to speak.

### RAILWAY TELEGRAPH SUPERINTENDENTS.

The annual convention of the Association of Railway Telegraph Superintendents will be held this year at Boston, June 19-23, inclusive.

This association has been in existence since 1882 and has done much toward the improvement of telegraph service. The developments of the last five yeares indicate that its work in the future will lie more with the telephone than with the telegraph. At the last meeting of the Western Division, held in St. Louis, Jan. 26, 1911, there was considerable discussion on this particular point. In starting it Mr. E. A. Chenery, superintendent of telegraph of the Missouri Pacific, said:

"The one subject that is always of interest to the railway telegraph superintendent is the use of the telephone. It is of interest not only because we feel that this association is the father of it, but also because it has taken so well that a railroad in this country now, I believe, is considered somewhat of a back number if it has not one or two circuits in contemplation or in working order."

Cnotinuing the same subject, Mr. W. W. Ryder, general superintendent of telegraph on the New York Central Lines, said:

"I don't think there is any necessity of my making an argument in favor of ehe telephone. I believe you are all on my side. On the roads with which I am associated, the managements are certainly strong advocates of the use of the telephone, and they have allowed us to make considerable progress during the last year, more particularly along the line of the use of the telephone for dispatching purposes, but not confined to that alone. We are getting into the handling of way office messages in the same manner, and hope to do more on that line this coming year."

Mr. H. D. Reed, superintendent of telegraph on the St. Louis & San Francisco, said in part:

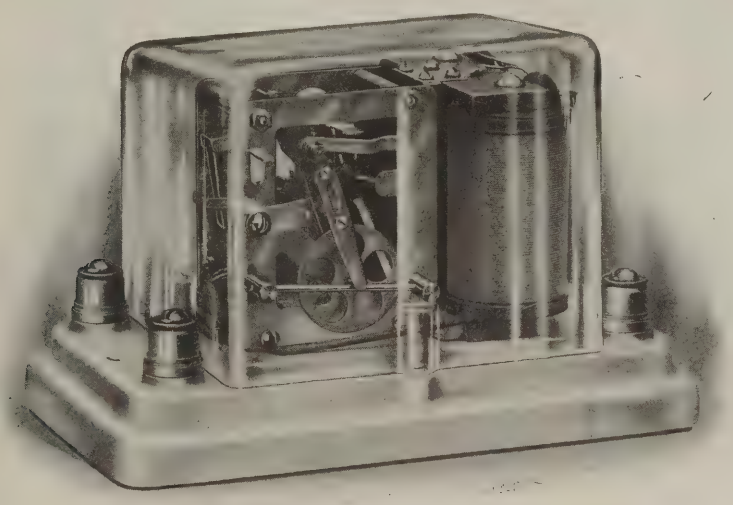
"We have today 750 miles of duplicate circuits, that is, both a dispatching and a message circuit. In addition to these we have a phantom circuit over the entire 750 miles. Our longest circuits are about 200 miles. We find that the telephone relieves congestion on dispatching as well as on message circuits. I think, with Mr. Ryder, that there is as great an improvement in handling our message service as there is in handling our trains. The phantom circuit has proved a great success.

# The Selector in Railway Telephone Service

By J. W. BARNEY

For more than half a century the electric telegraph has been in use on American railways and none can gainsay the value of the service it has performed. The developments of the past five years indicate the rise of a new instrument which, by reason of its greater efficiency and economy, seems destined to supplant the telegraph in meeting the constantly increasing exaction of the expedition and safeguarding of train movements.

The genesis of its development was a recognition of the weakness and limitations of the telegraph system as related to signaling the operator at the point with which communication was desired and the fact that all other business on the circuit was necessarily at a standstill while this was in progress. To remedy these objections systems of selective calling were devised, and it is worthy of remark that the chief factor in the spread of telephone train dispatching is the utilization of a device originally designed as an adjunct to telegraph service.



The Gill Type Selector

The new art is that of telephone train dispatching with the aid of selective calling, and allied with it, though still in its swaddling clothes, is the science of selective signalling and the absolute control of train movements by the dispatcher without dependence upon the obedience of orders by station operators.

Visitors at the Railway Appliances Show at the Coliseum next week will have an opportunity to inspect some of the apparatus by which these results may be attained. A brief sketch of them, necessarily incomplete on account of the limitations of space, is here given.

First, why a selector? The Morse call is unsatisfactory for several reasons, notably because it must, of necessity, be repeated until the office called is raised, and this to the exclusion of all other business over the line. While the line is in use for calling offices, its use by a large number of operators is prevented. These operators must remain within hearing of the call, and are thus unable to perform other work about the station. To reach a station at any time of the day or night two operators must be employed.

It was early surmised that an economical and satisfactory practice would be to raise offices by means of a continuously ringing bell but many attempts showed that this was not feasible, as in the code ringing first attempted it was impossible to ring a bell at the office desired without at the same time ringing a bell at every other office on the circuit. The first step out of the difficulty was a selective calling system.

This brings us to the second consideration. What is a selector? Selective apparatus in common use may be divided into two general classes, based upon the method of operation and distinguished as mechanical and electro-mechanical. The electro-mechani- type is so much more used than the other form that it may be considered as the most advanced product of the art.

The selector may be described as a device by which the electric circuit of any one of a number of audible or visible signals or other electro-mechanical devices associated with a telegraph, telephone or other electric line, may be controlled from a distant point, without affecting any of the other apparatus or devices associated with the same line. One of these selectors, the Gill type, is shown in the accompanying cut. The whole thing is small enough to slip into the top of a silk hat. The whole mechanism is mounted on a porcelain base and inclosed by a transparent glass cover, hermetically sealed to the base. Its essential features are a combination wheel and a time wheel, suitably governed by a magnet, levers and detents. Just as a combination lock will open only to its own setting, so the selector can be operated only by impulses of a predetermined number and sequence. The combination wheel differs in its teeth cutting in every selector on a circuit, and while a calling impulse sent over the wire actuates every selector, yet it will not go to the contact position and operate to call an office unless its individual combination is made.

The function of a selector is to discriminate and select from among the calls going over the circuit, those applying to its particular station; to turn over the work of calling the operator or agent to a bell. But a single call is necessary with this system. The bell at the station, including, if desired, an extension bell in outlying station buildings or in the operator's lodgings, may be rung by local battery or by the main line calling circuit, and the signal may be made to ring continuously or until cut off by the operator responding or by the dispatcher, or may be arranged to ring for a certain time. Provision is made for assuring the dispatcher that the call has been received at the station whether it is answered or not. In telegraphic calling the telegraphic answer-back repeats the call back in Morse characters and records, for the benefit of the absent operator, calls

received up to four in number. In telephone train dispatching the call at the distant station is plainly heard through the head receiver.

The selector in telegraph service is connected to the front or back contacts of the main line telegraph relays. The way station telegraph equipment is as shown in the illustration, where the selector is at the left of the relay. The calling may be done by Morse key sending over the line a predetermined number of impulses of current, properly spaced between each group of impulses, as the proper spacing may be acquired with a little practice. The preferable method is to use an automatic calling key. In this key the sending of the proper combination of impulses is accomplished by a simple train of gears operating a circuit breaker, somewhat similar to the familiar district telegraph box. A number of these keys are preferably assembled in a cabinet at the dispatcher's office, like that shown.

By giving the handle corresponding to the station desired a quarter turn, the signal bell at that station may be operated in a few seconds time, without any of the other stations on the line being affected. Furthermore, this calling may be done while a telephone conversation is being carried on over the wire. Automatic calling keys are used in telegraph, telephone, and signal service.

Telegraph Operator at a Way Station

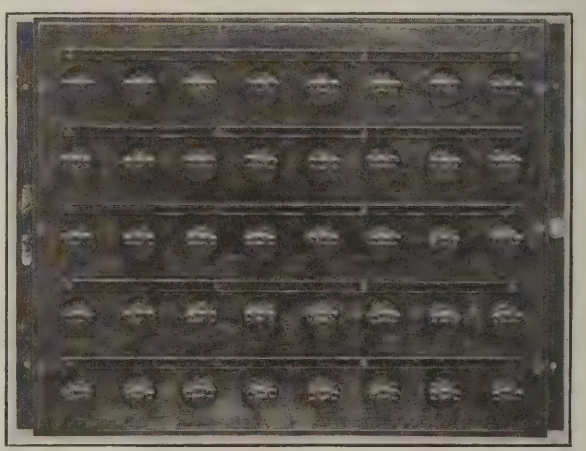
The telephone had been in common use for more than a generation before it was seriously considered for train dispatching. It had already come into use in other branches of railway service and the selector had been used with the telegraph. The first serious consideration of the substitution of the telephone for the telegraph in train dispatching was apparently that given in the discussion at the meeting of the Association of Railway Telegraph Superintendents, in June 1907, when much interest in the possibilities in this direction was expressed.

Three months later the New York Central installed and put in service between Albany and Fonda, N. Y., the first telephone train dispatching circuit equipped for selective calling. The selector used was similar to that shown in the illustration. The Federal law had imposed limits on the working hours of railway employees concerned in the movements of trains, and a shortage of telegraph operators ensued. Although the rural telephone service was well developed throughout the United States, telephone engineers and manufacturers had so far overlooked the railway field that when a reliable selective telephone calling system was wanted by the railroads the largest manufacturers of telephone equipment were unable to supply their needs, and it remained for the original inventor of the selector, Edwin R. Gill, and his associates to adapt the telegraph selective device to the operation of the telephone.

The physical differences between the telegraph and telephone systems of train dispatching are that the latter calls for the use of two copper wires in place of one iron wire, and telephone and selective calling apparatus in place of telegraphic apparatus. The operating differences are that orders are transmitted by speech instead of by the Morse code, and the stations are called selectively and distinctly instead of by a telegraphic sounder. The orders are issued orally by the dispatcher to the operator, or operators, word by word, in some cases words and figures being spelled letter by letter in order to insure accuracy. The dispatcher writes the order in his book as he dictates it to the operators, thus regulating the speed so that it may readily be copied. The same form of order is used as heretofore and operators receiving orders repeat them to the dispatcher for checking, the same as with the telegraph.

As a result of the troubles experienced with early installations, it was decided to wind the selector so that it can be bridged directly across the telephone circuit and operated without the use of relays or local batteries at the stations, and without causing a loss in telephonic transmission.

The two circuit diagrams make clear the forms of installation generally used in train dispatching. In calling with the local battery bell, two dry cells are provided at each station. They are used for ringing the bells only, as the current for the operation of the selectors is furnished from the main signalling battery located usually in the dispatcher's office. On some roads it is considered that a louder and more insistent signal is obtained from a bell operated by the local battery than from one operated by the main signal battery.

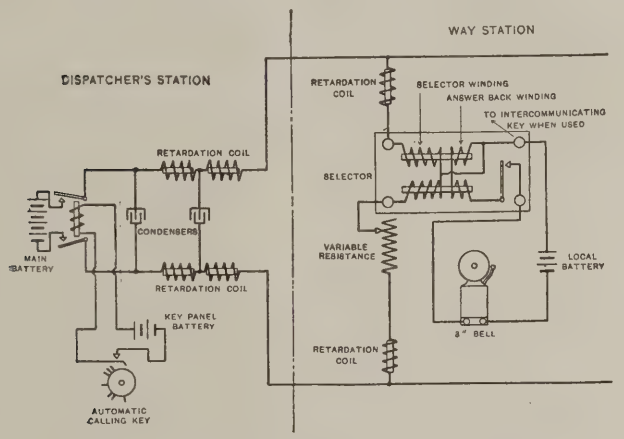


Automatic Calling Cabinet

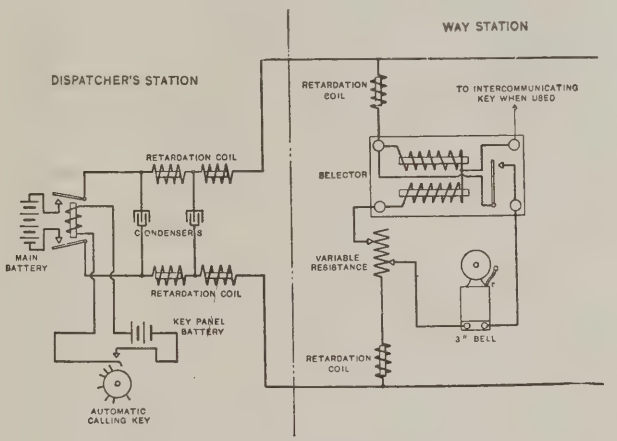
With the main line bell circuit arrangement no batteries are used at the stations to ring the bells, as both the selector and bell are supplied with current by the

main signaling battery. This arrangement reduces the station apparatus to a minimum and removes the dry batteries as a possible source of local trouble. The main line bell arrangement causes a slightly larger flow of current from the main signaling battery every time a station is called, but as high resistance bells are used and as but one bell is in circuit when a station is called, the increased current draft is not objectionable. Storage cells are preferred for the main signaling battery.

The half-tone cut shows the interior of the station box outfit for calling by the main line bell. The large numbered coil over the selector is a universal resistance coil affording, according to the connections any resistance desired from 0 to 25,600 ohms. In addition to

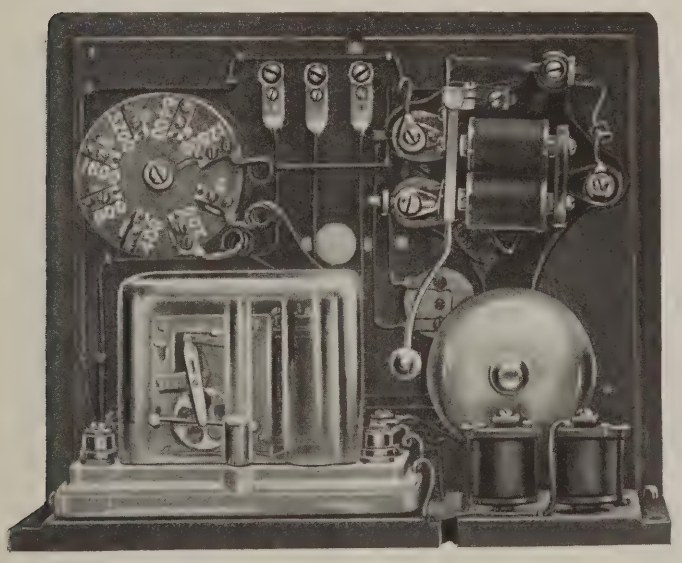



Main Line Circuit Bridged Telephone Selector




Local Bell Circuit Bridged Telephone Selector

telephoning and operating the selectors over a telephone line, a through telegraph circuit may be obtained over the same wires without interfering with either of the telephone conversations or the operation of the selector. In other words, during a telephone conversation, the bell at another station may be rung and a telegraph message be sent between the terminal stations, all occur-



Station Box Outfit

ing simultaneously and without interference with any of the three kinds of service.

Telephone train dispatching provides a means of utilizing in the railroad service the knowledge and training of employees who may have become incapacitated for continued service in train operation who are still able to operate a telephone. With the selective systems and telephone train dispatching such a man becomes the equal of a Morse operator so far as the transmission of intelligence and the dispatching of trains is concerned plus the experienced railroad man.

A conservative estimate shows that with telephone dispatching the dispatcher transacts his business in about one-half the time required when the telegraph was used. Actual competitive records taken on successive days on a western road showed that, as compared with the telegraph, the telephone handled 20 per cent more orders in an average of less than 59 per cent per order, of the time required by telegraph dispatching. The expedition of train movement amounted on a road about 400 miles long, to a saving of one and a half to two hours time in freight train movement between terminals. Telephone dispatching means the getting of cars back to terminals much quicker than can possibly be done on a heavy division with the telegraph.

Selectors are working in train dispatching service in circuits up to 276 miles in length. Their constancy of service may be evidenced by the statement of a railway system with over 600 selectors in service, which reports that many of its circuits have been operated one or two years without a single case of selector trouble and that difficulties with the selectors will not average one per circuit per year.

## EXTENT OF TELEPHONE TRAIN DISPATCHING.

Although it is only about five years since the first railway train dispatching telephones were installed, there are today over 35,000 miles of railway operated by their use. These lines are in every sort of territory from the densely populated with very heavy traffic to the deserts of the west. 89 per cent of the Lake Shore and Michigan Southern's mileage is dispatched by telephone; 46 per cent of the Michigan Central, 50 per cent of the Big Four, 65 per cent of the Lake Erie and Western and 100 per cent of the Chicago Indiana Southern and Indiana Harbor Belt Lines. The Santa Fe has ordered equipment sufficient to equip over 4,600 miles of its line. About 20 per cent of the Illinois Central is already so equipped. Practically all train movements on the Delaware, Lackawanna and Western are directed over the telephone. The Great Northern has over 1,500 miles of train dispatching telephone circuits, or about one-fourth of its total mileage. The Pennsylvania has considerably over 1,000 miles, about 20 per cent of its lines. And this is but the beginning.

# Wireless on the Railways

## THE PRENTICE SYSTEM OF WIRELESS TRAIN CONTROL.

The Prentice System of train control of which Frank W. Prentice is inventor and patentee has been successfully tried out on the Canadian Pacific Railway at West Toronto. The installation consists of eight blocks, from 2,000 to 4,500 feet each and has been in continuous service since Mar. 25, 1910. It is claimed that the operating cost does not exceed two cents per day per block.

In an actual test made on Dec. 8, 1910, train of 12 loaded freight cars traveling at a rate of 45 miles per hour was brought to a standstill under a full head of 195 pounds of steam in 1300 feet, or about 30 seconds.

There are two parts to this system: First, that part which is on the track, and second, that part which is on the train.

The essential features of the track portion (Fig. 1),

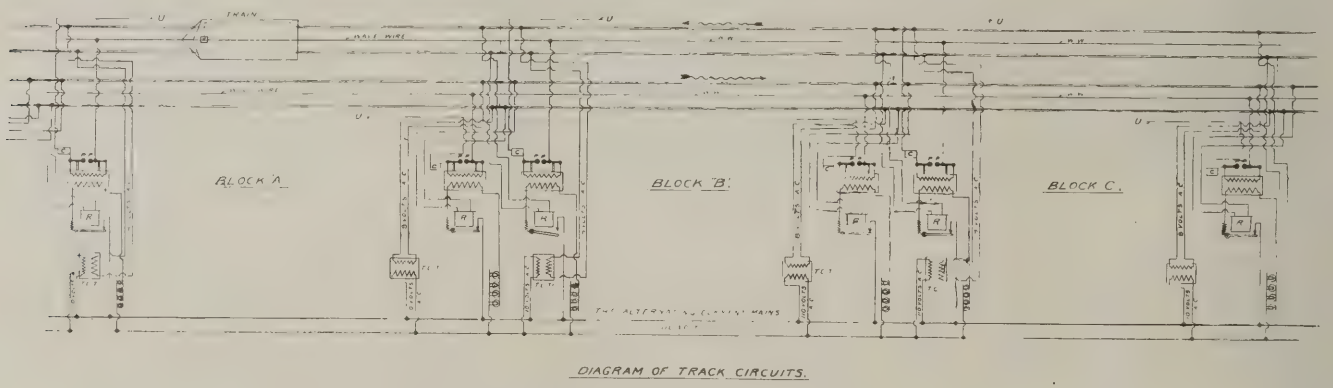



DIAGRAM OF TRACK CIRCUITS.

Fig. 1. Diagram of Wireless Track Circuits.

are the track circuit and the generator of the wave. The generators, as a whole include the transformer T, the condenser C, and the discharge points PP, commonly known as oscillators. One of these generators is placed at the end of each block, and a wave wire is extended for a block length in the rear. The wave wire that is used is No. 12 aluminum, and is run in a trunking in the centre of the track, midway between the rails. The generator is controlled by the track circuits of the block in advance. As long as the flow of current through the track circuits is not broken or short circuited, the a. c. relay R, keeps the generator connected with the a. c. feed wires, stepping the 110 volts up to 22,000 volts which causes a static discharge to continuously take place between the oscillators, P.P. Connected to the oscillators will be noted the wave wire, W, and pick-up wire, U, extending along the track in the relative positions shown. All the track blocks are provided with the ordinary form of vane type relays and a. c. track circuits.

The wave wire W, is insulated from the track, and its preferred position with reference to the track is along the middle of the ties as shown. On single track the wave wire is placed near the end of the ties. The maximum length of the wire which can be charged with one oscillator is measured by miles, so it is plain that the lengths of the blocks are governed, in actual operation, only by the requirements of traffic. The maximum distance for a. c. track circuits is 16,000 feet, while that of d. c. track circuits is 3,000 feet.

The part of the system which is carried upon the engine consists of:

(1.) The main antenna, nineteen feet long, suspended from the boiler braces by three hangers, the antenna consisting of aluminum plate four inches wide, and hanging directly over the wave wire, two inches above the level of the pilot or seven inches, from the indurated trunking.

(2) A pick-up antenna suspended in a like manner on the right-hand side, suspended beneath the cylinder cocks, thirteen inches outside of the rail and directly over the pickup wave wire at the end of each block.

(3) A turbine generator giving six volts and twenty amperes of current for supplying the working force of the wave responsive apparatus.

(4) The train control mechanism, the salient feature of which is the coherer (Figs. 2, 22 and 23), consisting

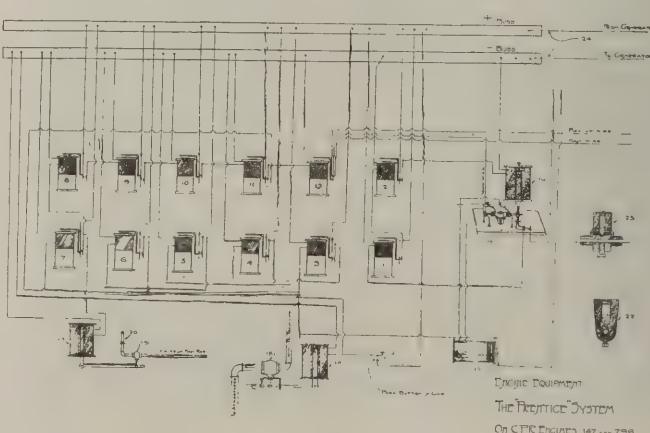



Fig. 2. Wiring of Locomotive Equipment

of a wood fiber receptacle having a hole in the center, and two lugs inserted in its bottom ¼ inch apart, the filings being placed in this space.

The coherer is rotated upon an axle through ninety degrees of space by a solenoid rack and pinion, being held in the upright position two seconds each time, in which position the wireless wave makes the coherer a conductor, closing the master relay, 15. The coherer is in operation constantly as long as an engine is in service. The master relay opens and closes every three

seconds when the wave is being received. Connected to the master relay is a series of ten hold relays, 3 to 12, inclusive. These relays will hold their magnetism one second each after the current is broken, and being in parallel series relay 12 releases its contact ten seconds after the master relay ceases to be operated by the wave controlling influence.

Relay No. 7, when closed, energizes solenoid 13, whose

Frank W. Prentice.

plunger holds closed valve 19, which prevents the air from the main reservoir blowing whistle, 20.

Relay 11 through its contacts energizes solenoid 14, which through its fulcrumed solenoid holds closed balanced valve 18, preventing the escape of air from train line through a one-inch port.

Solenoid 14 is also subject to control by a push button, 21, located in cab of engine, by the engineer.

Track Wireless Control Installation.

Relay 12 has a front and back contact and a common connection with coherer 17. When relay 12 is closed its common is in connection with the main wave wire antenna under the engine, and when disengaged is in connection with the pickup antenna located under the steam chest.

When the engine enters the wave zone the wave is caught by the pick-up antenna, reaches the coherer through its contact on relay 12, closes master relay 15, which in turn closes relays 3 to 12. The engine is now under control of the wave and as long as the wave is being received master relay 15 will be opened and closed every 3 seconds; consequently relays 3 to 12 will remain closed.

If there is a train standing in front of the oncoming train, the wheels of the standing train short circuit the current and stop the wave. The coherer fails to receive the wave and the master relay, 15, remains open. In one second relay 3 opens and relays 4, 5, 6 and 7 open successively, each one second later. In 5 seconds after entering the block solenoid 13 drops its valve, 19, and whistle, 20, starts blowing. Four seconds later relay 11 opens, de-energizing solenoid 14, the train line valve is opened, and the air brakes are being applied to engine 10 seconds after the danger zone is reached.

## WIRELESS TELEPHONE EXPERIMENTS ON UNION PACIFIC.

On February seventeenth, Dr. F. H. Millener, of Omaha, Nebraska, told the New York Railway Club something of the wireless experiments he has been making on the Union Pacific. These experiments have been in progress for the last four years. The problem is to supplement the electric automatic block signalsl with wireless telephones so that traffic will never be need-

Locomotive Equipment for Wireless Control.

lessly delayed through failure of signals to operate correctly.

Some extracts from Dr. Millener's interesting paper follow:

On a railroad an electrically-controlled automatic block signal must work at least 100,000 times without a failure. The hundred thousandth time, perhaps, it may go wrong. The lighting of an arc lamp or some atmospheric disturbance may cause the signal arm to fly up and the signal to be set at "danger." The engineer of the train that it halts has to wait until he gets orders to proceed. On these rare occasions when the signals go wrong the track may be clear; but the engineer does not know anything about what is ahead of him except what the signal tells him. Therefore, he waits. The delay may be so long that traffic may be delayed in an ever lengthening line from the point where the signal has stopped the movement of the trains. This costs the railroad more or less money. It means the loss of the productive labor of a great many employees and the idleness of a lot of rolling stock, as well as annoyance to travelers and shippers.

Now the Union Pacific has the finest system of block signals of any railroad in America. Perfect as it is, however, there is this remote but possible element of delay that must be eliminated. The Union Pacific decided that the only way to do so was to devise some means by which an engineer in his cab could "call up" the train dispatcher's office and find out what was

wrong. Therefore, about four years ago, I was asked to devise a means of overcoming this difficulty. The solution seemed to be in wireless communication by telephone.

We have been prosecuting these researches ever since then. The conclusions we have reached have been satisfactory. Wireless telephony from a moving train is more than a practical probability and within a year or so from now it will a feature of the daily operation of trains on the Union Pacific. If we save one fruit train from freezing it will pay the cost of practically the whole installation. More than that, however, it will make travel by rail even safer than it is now on the safest of railroads. With properly constructed wireless stations there is no chance of failure. There will be no more trouble with the block signals, no delays or annoyances because wires have been blown down by storms, or anything of that sort.

Two of these wireless stations will be established soon, one at Sidney, Neb., and the other at Cheyenne, Wyo., 103 miles apart, where the line is a single track. We expect to keep up communication with moving trains between these stations and others that are to be established. These wireless stations will be close to the train dispatchers' offices, so that communication may be established quickly whenever it is necessary. We have discovered, through our experiments, that wireless waves will follow the direction of the rails farther than in any other direction and more closely. It is well known that they will follow a stream of water or metallic conductors better than they will pass over wooded country or even a treeless plain, and that these waves work better in stormy weather than when the skies are clear.

The wireless telephone that we have devised and have been using in Omaha is sufficiently powerful that messages may be received from a considerable distance simply by attaching the receiving apparatus to an ordinary umbrella, which is held over the head of the person who gets the message. He may be on top of a moving train or walking about the yards. The tones of the human voice are reproduced perfectly—far better than by the ordinary telephone. The ordinary telephone "head set" is used by the person receiving. The ribs of the umbrella correspond to the antennæ or aerials. Using an umbrella for this purpose, however, is a wasteful method, because it requires more electricity. Therefore, it must not be inferred that all our train employes will carry umbrellas in the future.

During our investigation in wireless telephony we made a thorough study of what is called the "speaking arc" in connection with generators capable of producing currents as high as 350,000 alternations per second. As a result of these researches we developed a bank of six arc lights which we caused to talk and give forth musical sounds, when persons spoke or musical instruments were played into the telephone transmitter.

Another thing we did in the course of our research work was to take an electric truck weighing 5,500 pounds and run it around the shop yards at Omaha by wireless waves. The car was equipped with an aerial and we ran it at four different speeds, forward and back, under perfect control.

## WIRELESS IN RAILWAY SERVICE.*

**By Lee De Forrest.**

Experiments conducted at New Haven, Conn., and Toronto, Canada, demonstrated the correctness of my view, that the track rail system, including the mass of telegraph or telephone wires along the right of way served not only as a conducting zone or wave chute along which the electric waves preferred to travel, but also acted as a net to catch waves coming transversely and obliquely towards the right of way, and then distributing in both directions along the track a surprisingly large amount of electric energy. On account of the directive action of the telegraph wires it is easy to pick up strong wireless telegraph signals by a wave detector connected to a short horizontal wire stretched parallel and near to the telegraph wires, and at a surprisingly large distance from the wireless station.

From this it is easy to understand how a track-side wireless station, using a horizontal antenna, a wire, say, 100 ft. long fastened to two or three telegraph poles, can communicate with another track-side station similarly arranged, and distant 20 or even more miles from the first. Obviously one or both of these stations can be located on board a train, and in such case the horizontal antenna wire can, as I have demonstrated, be run inside the cars, of heavily insulated wire, parallel to the bell cord. This is, of course, pro-

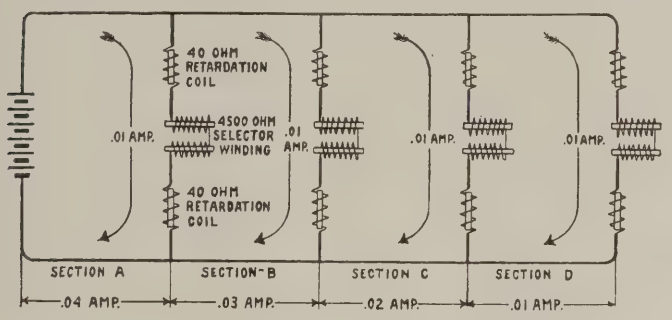
By this arrangement it would be a comparatively simple matter to telegraph regularly to and from express trains, over a distance of, say, 40 miles (20 miles on each side of the track-side station); but the expense of carrying a telegraph operator on board, more than the cost of the equipment entailed, would greatly limit the application in practice.

With the wireless telephone, however, the case becomes very different, so different in fact that it is my firm belief that ere many years the telephoning to moving trains, and especially to locomotives, will become a very common, or well-nigh universal, adjunct to our elaborate railroad safety appliances. For such a purpose a long distance of communication will be quite unnecessary—in fact, undesirable. Consider a railroad system equipped with the block system, with signal stations or towers at mile intervals; a small wireless telephone transmitter capable of half-mile communication, and utilizing the inductive or "wave-chute" action of the existing telegraph wires, would cost little to install, little to operate and be so simple as to add practically nothing to the training of the signal operator. A horizontal antenna wire would be extended to the first or second telegraph pole stretched 3 ft. below the lowest telegraph wire; the earth connections would be directed to the track rails. On the locomotive or over the locomotive and the first coach will extend an insulated wire as easily coupled up when making up the train as is the air brake at present. In the cab a small box is fastened containing a tuning coil and a simple crystal wave detector; connected to this is a single head telephone receiver with head band attached, or a telephone receiver with rubber air pad is fastened to a short arm at a point where the engineer can easily rest his ear against it. The body of the locomotive, of course, supplies the earth connection. This system would enable the signalman to talk direct to the engineer for a period of one to four minutes, and add immensely to the probability that he will perceive the proper signal, or enable him to receive orders or information which the semaphore cannot possibly communicate. The engineer could not, of course, reply, except by whistle. It would appear that by this appliance it will be generally quite unnecessary for a train to stop merely to receive dispatcher's orders.

*Abstract from an article in the "Telephone Engineer."

# Telephone Selector Resistances

On the Dope Sheet, page 238, will be found a table of resistances to be inserted at each station in a train dispatching or message circuit in order that a current of .010 ampere may pass through each selector. In computing this table certain factors have necessarily been taken as fixed. It has been assumed that the interval between stations is 5 miles and that the circuit is made up of No. 9 B. & S. Guage hard drawn copper




Current Distribution on Selector Circuit

wire. This wire has a diameter of .1144 inch, and a weight per mile of 208.88 pounds. Ordinarily it is spoken of as 210 pound wire. Its resistance is 4.18 ohms per mile or 8.37 ohms per circuit mile. The resistance of the circuit between any two stations is therefore practically 42 ohms.

This size of wire is standard for circuits of this sort. The five mile interval is a fair average of the conditions occurring in actual practice.

The method of computation is extremely simple. The resistance of each interval x the current flowing in this interval gives the resistance for that section. The total resistance to be inserted at any station equals the sum of the resistances of the sections between the station and the dispatcher's office.

This can readily be seen by reference to the accompanying diagram for which acknowledgement is made to Mr. W. E. Harkness.

The table is computed for each station up to 12 on circuits containing from 2 to 30 stations and on every other station from 12 to 30 . As the exact resistance is not required the resistance at any station can be found with sufficient accuracy by taking from the table the resistance at the station the distance of which from the dispatcher's office is most nearly that of the station required.

For instance, suppose a 4 station circuit with stations 6, 11 and 15 miles distant, respectively from the dispatcher's office. The exact resistances would then be:

| Station | | Interval Miles | Current Amperes | Resistance Ohms |
|---|---|---|---|---|
| 1. | (Dispatcher) | 6 | .030 | 265 |
| 2. | | 5 | .020 | 115 |
| 3. | | 4 | .010 | 33 |
| 4. | | | | 0000 |

The exact resistance would be 265, 115 and 33 ohms, whereas the resistances taken from the table would be 42,126 and 252 ohms, which is sufficiently close for all practical purposes.

# An Electric Railway's Telephone Equipment

Electric railways, especially those paralleling steam roads and competing with them for through traffic, find fast train schedules an important factor in securing their share of the business, and any slight decrease in the running time between terminal points usually

Fig. 1. Train Dispatcher's Office at Salem

results in a corresponding increase in business. On all railways, especially those on which the limit of safety and capacity of the equipment has been reached, a good system of dispatching and an efficient, reliable system of communication between all parts of the system has resulted in not only better running time but a better maintenance of schedules.

An excellent example of how an efficient system of communication will quicken train service and aid generally in handling the business of the road is afforded by the New Hampshire Electric Railway on its lines operating around Haverhill, Lawrence, Lowell, Nashua, Hampton Beach, Salisbury Beach and intermediate points. This railway system uses the telephone in connection with its train dispatching to connect the repair shop with the various car houses, to connect the power house with the rotary stations and for general purposes, such as reporting defects in cars, track and overhead lines, and ordering supplies for various car houses.

### Main Telephone Circuits.

The telephone system is divided into two general divisions corresponding to the divisions of the road, namely, the Eastern and Western Divisions. In the Eastern Division, which is subdivided into the Eastern New Hampshire and Eastern Massachusetts Divisions, the main switchboard is located at Amesbury, with pony switchboard at Plaistow and the Amesbury and Salisbury car houses. This division covers about sixty miles and the road is equipped with twenty-eight

telephones. The Western Division is made up of five subdivisions—

Canobie Lake,
Haverhill-Salem,
Salem-Pelham, with branches to Nashua and Lowell,
Salem-Lawrence, and
Haverhill Junction.

The main switchboard is located at the Salem car house, with pony boards at the Pelham car house and at the general offices of the company at Haverhill. This division of the road is 47 miles in length and is equipped with thirty telephone stations, in addition to those in use at Canobie Lake Park.

**Auxiliary Telephone Circuits.**

There are also two other telephone circuits, one connecting the car house at Salem with the machine shop and the houses of the master mechanic and superintendent, the other a circuit paralleling the high tension transmission lines, which sup-

Fig. 2. Telephone Equipment at Siding

plies the power for the road. The power for operating the trains is generated at Portsmouth, New Hampshire, and transmitted at 13,200 volts, alternating current, to sub-stations at Dover, Stratham, Plaistow, Amesbury, Salem, Methuen, Pelham and Hampton, where it is converted to 600 volts, direct current. The telephone line paralleling the transmission line is 55 miles in length and is equipped with telephones at each rotary station. The high tension patrolman always carries a portable telephone and by cutting into the line, can connect with any point desired.

The dispatchers at Salem and Amesbury can keep in constant touch with the power house at Portsmouth and each of the rotary stations. In case of a breakdown on the high tension circuit, if a rotary station gets damaged during heavy storms, the heads of the departments can be notified at once and the necessary steps taken to clear the trouble immediately.

Although the Canobie Lake Division is the shortest, being but 1.5 miles in length, it is one of the busiest divisions in the system during the summer from the fact that an amusement park is located at Canobie Lake.

Canobie Lake Park comprises approximately 50 acres of land and forest, having its frontage on Canobie Lake. It is easily reached by trolley from all points in New England. This park is situated in the town of Salem, New Hampshire, 45 minutes' ride from the cities of Haverhill, Lowell and Nashua, and 30 minutes' ride from the city of Lawrence. The management caters especially to societies, churches and organizations, to whom special inducements are offered. It is estimated that approximately 500,000 people were in attendance at this park during the season of 1910.

**Method of Dispatching.**

The dispatcher for the Western Division is located at the Salem car house (see Fig. 2), and from this point he controls all the cars on this division. The telephone equipment here consists of a Western Electric switchboard of thirty-line capacity, with trunk lines running to pony switchboards located at Haver-

NEW HAMPSHIRE ELECTRIC RAILWAYS
WESTERN DIVISION

Despatching Order No._____ Date_____190___

_____

_____

_____

_____

_____

_____Conductor _____Motorman

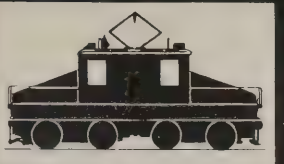
Correct at_____M. _____Despatcher

Fig. 3. Form Used for Train Orders

hill and the Pelham car houses. At each siding and at other important points along the line there is a telephone booth (see Fig. 3), in which is installed a telephone set, a lightning arrester and an Egry triplicate copying machine. This machine makes three copies of each order, one of which goes to the conductor, another to the motorman, and the third winds up within the machine, which is locked and is used to verify any reports should occasion arise as to just what the order was. The conductor after receiving his orders from the dispatcher writes them out and then repeats them back to the dispatcher, who gives O. K. and puts down the time on his train sheet. Fig. 4 shows one of the forms used. The dispatcher enters his orders on a regular train sheet similar to that used on steam roads, and he is held responsible for the service.

This system of dispatching is used on both Eastern and Western Divisions, when extra cars are run over the various lines. When the regular schedules are in force, all cars pass at designated points and dispatching orders are not given except for the control of line or construction crews, during delays or when accidents occur.

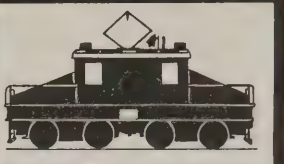
The switchboards and telephone apparatus of the entire system was furnished by the Western Electric Company, which has supplied numerous electric roads with telephone apparatus in addition to over fifty of the largest steam roads in the country.



# ELECTRIC TRACTION SECTION

EDITED BY

C. L. DE MURALT



# New European Single Phase Locomotive

We are very much pleased at being able to present to our readers this month the first pictures and a detailed description of a highly interesting European electric locomotive just completed. We refer to the single-phase alternating-current locomotive built by the Maschinenfabrik Oerlikon for the Swiss Loetschberg Railway, which connects Bern with the Simplon by way of the Bernese Oberland.

The line is today operated by steam from Bern, via Thun and Spiez, to Frutigen. Electric operation is at present being introduced between Spiez and Frutigen. Beyond Frutigen lies the Loetschberg, forming part of the chain of snow mountains which separate the Bernese Oberland from the Valley of the Rhone. This chain is now being pierced by the Loetschberg tunnel. As soon as the tunnel can be finished, the entire line will be electrically operated.

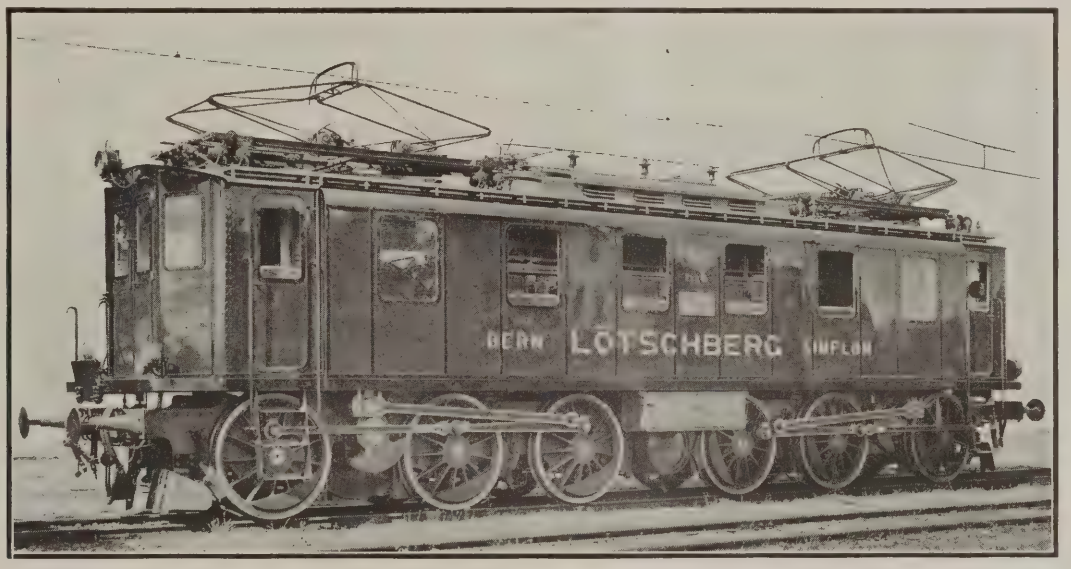



Fig. 1. New Loetschberg Single Phase Locomotive

It is interesting to note that electricity as motive power was decided upon, partly because the greater power of the electric locomotive permitted the use of a steeper grade than would have been advisable with steam, but principally because a very careful investigation showed that the cost of operation will be materially less with electricity than with steam.

Electrical energy can be bought from the already existing Kander River Power Plant near Spiez at about one cent for the kilowatt-hour delivered at the power house switchboard. The same plant furnishes electrical energy to the well-known three-phase railroad from Thun to Burgdorf, which has been electrically operated by the three-phase system ever since 1898. Cost figures obtained from the latter road proved beyond the possibiilty of a doubt that electrical operation with electricity at one cent per kilowatt-hour was cheaper for the Loetschberg Railway than steam operation, even when electric operation was debited with the full quota of increase in fixed charges due to the extra investment in electrical equipment.

The Loetschberg line is built with a ruling grade of 2.7 per cent, and the electric locomotives are required to draw a train of 310 metric tons (about 340 American tons) up this 2.7 per cent grade at a speed of 42 kilometers (26¼ miles) per hour.

Trial runs already made with the first electric locomotive, illustrated in Fig. 1, showed the following: Operated at an electric pressure of 15,000 volts and at a frequency between 13 and 17 cycles per second, this locomotive can develop continuously 2,000 horsepower at 42 kilometers (26¼ miles) per hour, and a tractive effort of 13,000 kilograms (28,600 pounds). The speed can be regulated readily from zero to 70 kilometers (43½ miles) per hour. The starting tractive effort can be increased to 15,000 kilograms (33,000 pounds).

The total weight of this locomotive is 88 metric tons (about 97 American tons), all on drivers. The total length is 15 meters (50 feet).

The locomotive is built upon two bogie trucks, each with three driving axles, somewhat similar to the Pennsylvania direct-current locomotives, but, where the Pennsylvania locomotive has its cab divided into two parts, one for each truck, this Swiss locomotive uses one single cab placed on top of the two trucks. The general arrangement is very well shown in Fig. 1.

Fig. 2 shows one of the trucks with the cab removed and one of the motors exposed.

Each truck has one motor of 1,000 horsepower, mounted well up on the truck frame. High-speed motors are used, running at 510 revolutions per minute, and they are geared to jack shafts with a ratio of 3.25 to 1. Gear and pinion are made of a special

grade of forged Siemens-Martin steel and the teeth are cut in double herring bone fashion with well rounded angles.

The jack shafts are placed eleven inches above the driving axles and are connected to the latter by means of driving rods nine feet long, the three pairs of drivers being connected together by means of parallel or side rods.

The high-speed motor shaft is six feet above the rails. It is thus seen that the center of gravity is relatively high, without, however, being extreme in this respect.

Each locomotive half is independent of the other and has its own current collecting device, its own transformer, its own motor and its own switches, but the control circuits are so arranged that either or both halves can be governed from a common controller at either end of the locomotive.

Fig. 3 shows the interior of one of these controller stands, which looks truly ship-shape in its neat and simple arrangement. Immediately in front of the motorman are the handles for the control of the electric equipment, to the right are those for the air, against the walls between the windows are the gauges for air and electricity, and behind him is a neat switchboard which gives control of the various auxiliary electric circuits.

In cases of emergency he can entirely cut out one of the motors and run the locomotive with the other one alone.

A novel feature lies in the fact that the locomotive is built primarily for operation on single-phase currents, but can be used on three-phase or direct-current circuits as well. For operation on three-phase currents, the two transformers are connected on the Scott principle, each motor receiving single-phase currents from its own transformers. The locomotive can thus be operated, for instance, on single-phase current in the stations and on three-phase currents on the line.

### Electrical Equipment.

The motors, which weigh 19,200 pounds each, including reducing gear, are of the 12-pole compensated series type, designed to operate on 450 volts alternating or 400 volts direct current, without sparking at the commutator. The magnetic field of the motors is so dimensioned that, even during a start with maximum tractive effort, the pressure between commutator segments will not exceed 4 volts. Carbon brushes are used which do not cover more than three segments at any time. Resistances between armature winding and commutator segments have been omitted, and these connections have been made of very large cross section, so as to insure great mechanical strength and low temperature. By the use of auxiliary commutating poles the operation has been made practically sparkless at all speeds and loads. The motors are arranged for artificial cooling, and thus operated their heating under continuous load does not exceed 62° C. for the commutator, 60° for the stator and 75° for the rotor. The efficiency between half and full load has been found to be 90 per cent, the power factor at all speeds above about 20 miles per hour is 95 per cent. The motor frame is made in two halves. It is interesting to note that the air gap is only 3 millimeters (a little more than one-tenth of an inch), but the thickness of the babbit in the bearings is 2 millimeters, so that in no case is there any chance for the rotor to rub against the stator.

The transformers are of 1,000 kilovolt-amperes capacity each and arranged for cooling by means of air blast. Fig. 4 shows one of these transformers in detail. The 15,000-volt primary terminals are plainly seen in front, the 450-volt secondary terminals on top. There are eight of the latter and each is provided with its own switch or contactor mounted on the transformer and operated by relay circuit from the controller. The two transformers thus offer 16 different secondary pressures, corresponding to 16 different speed positions on the controller, from zero to 43 miles per hour. There is a special secondary tap for about 300 volts for the electric heating circuit which requires a maximum of 100 kilowatts. The transformers weigh 12,100 pounds each, and it was estimated that by using air-cooled transformers in preference to oil cooled, a saving in weight of practically 2 tons per transformer was effected. The efficiency of these transformers is above 95 per cent for all loads between 200 and 1,300 kilovolt-amperes.

As auxiliary apparatus the locomotive has a motor generator with storage battery to furnish direct current for train lighting, an 8-horsepower series motor to operate the air compressor which furnishes compressed air for the brakes and the control mechanism, and a 10-horsepower motor which operates the blower to keep the motors and transformers cool.

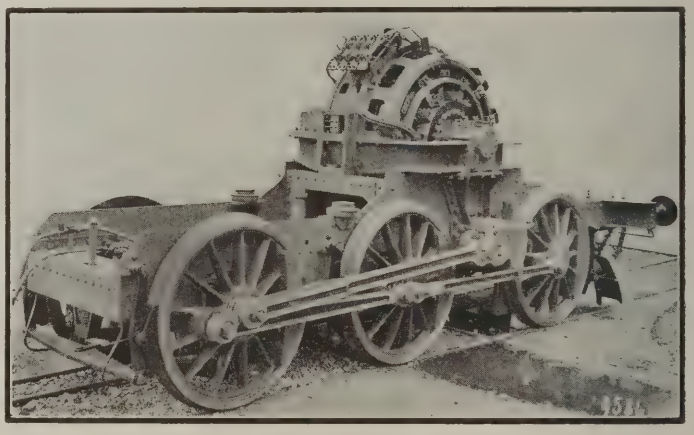


Fig. 2. Truck, Showing Mounting of Motor

This very interesting locomotive owes its origin to the initiative of Mr. L. Thorman, the well-known Swiss engineer. It is extremely well conceived in its general features and carried out with the greatest possible care in every detail.

The use of a high-speed motor with gear reduction and air blast cooling has permitted a great reduction in weight. The makers estimate that a slow speed motor would have been at least 50 per cent heavier and would have required at least 50 per cent more space, besides involving a considerably higher magnetizing current and a greater pressure between commutator segments, which would have made commutation much less satisfactory and would have increased maintenance and repairs.

The decrease in weight is very material and important. Where former single-phase locomotives could show only about 10 horsepower per ton, this Loetschberg locomotive weighs 97 American tons and develops 2,000 horsepower, or about 20½ horsepower per ton.

It is interesting to compare this with the latest direct-current and three-phase locomotives and to see what the latter could have done on the Loetschberg in the way of handling its traffic.

**Comparison of Hauling Power of Single-Phase, Direct Current and Three-Phase Locomotives.**

The Pennsylvania direct-current locomotive weighs 165 American tons and develops 4,000 horsepower. Or each half weighs 82½ tons and develops 2,000 horsepower. In either case, 24½ horsepower per ton.

The Giovi three-phase locomotive weighs 66 American tons and develops 2,000 horsepower, or 30¼ horsepower per ton.

A locomotive weighing 97 American tons—the weight of the Loetschberg locomotive—if built for direct current along the lines of the Pennsylvania locomotive would therefor develop about 2,400 horsepower, and if built for three-phase currents along the line of the Giovi locomotive it would develop about 2,900 horsepower.

The 2,000 horsepower Loetschberg locomotive can haul a train requiring a tractive effort of 28,600 pounds at 26¼ miles per hour ($\frac{2{,}000 \times 375}{28{,}600} = 26\frac{1}{4}$).

A direct-current locomotive of the same weight

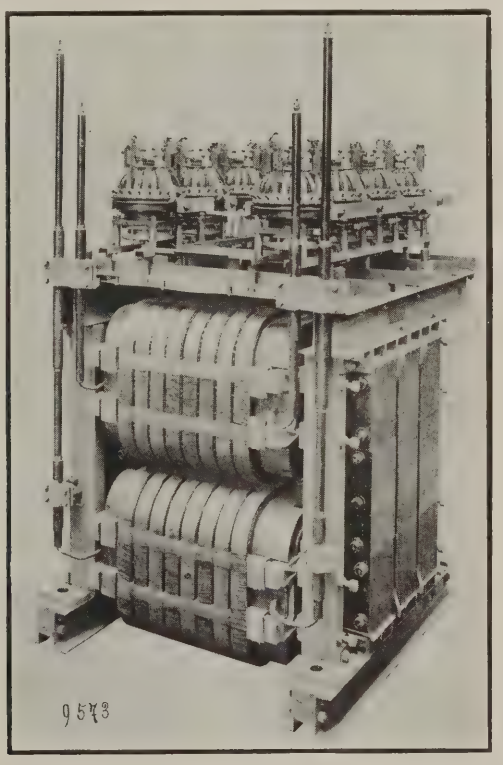


Fig. 3. Transformer of Loetschberg Locomotive

could draw the same train at 31½ miles per hour, and a three-phase locomotive could do it at 38 miles per hour.

This shows an increase in speed of 20 per cent in favor of direct current and of 45 per cent in favor of three-phase traction.

It is possible, however, that no higher speed than 26¼ miles per hour is desired or permissible on the Loetschberg. If this is so, then the comparison can be made as follows:

At 26¼ miles per hour the 2,000 horsepower Loetschberg locomotive can exert a tractive effort of 28,600 pounds, of which 6,600 pounds are required for the moving of the locomotive and 22,000 for drawing a train of about 340 American tons.

At the same speed a direct-current locomotive of the same weight would exert a tractive effort of 34,300 pounds. Deducting 6,600 pounds for moving the locomotive, as above, there remain 27,700 pounds which could be used for drawing a train of about 430 American tons.

A three-phase locomotive of the same weight would at the same speed exert a tractive effort of 41,500 pounds, or, after allowing the same 6,600 pounds for the locomotive, a net drawbar pull of 34,900 pounds, which is sufficient for hauling a train of 540 American tons.

Thus we find an increase of hauling capacity, at the same speed, of 26½ per cent for the direct current and 59 per cent for the three-phase locomotive as compared with the single-phase locomotive. And these values are well within actual practice. A 97-ton locomotive with all its weight on drivers is good for at least 42,500 pounds tractive effort on the basis of the usual conservative coefficient of adhesion of 22 per cent.

If the example of the Loetschberg locomotive were followed and high-speed motors with gear reduction and air-blast cooling were used for the direct current and the three-phase locomotive, their respective hauling capacity would be still greater.

Summarizing, we find on the basis of actually built locomotives the following comparative values:

Fig. 4. Cab of Loetschberg Locomotive

Speeds that can be attained by a 97-ton locomotive while developing a tractive effort of 28,600 pounds (grade 2.7%):

| | | | |
|---|---|---|---|
| Single phase, | 26¼ | miles per hour, | 100% |
| Direct current, | 31½ | miles per hour, | 120% |
| Three phase, | 38 | miles per hour, | 145% |

Train weights that can be hauled by a 97-ton locomotive at 26¼ miles per hour (grade 2.7%):

| | | | |
|---|---|---|---|
| Single phase, | 340 | tons, | 100% |
| Direct current, | 430 | tons, | 126½% |
| Three phase, | 540 | tons, | 159% |

## STORAGE BATTERY CARS FOR BRANCH LINES.

The use of the storage battery car for branch line services is being strongly advocated by manufacturers. It is claimed that these cars can be operated at a total expense of not more than 15c per car mile. This figure seems rather low in view of the comparatively low efficiency which has so far been shown by actual tests.

# The Practical Operation of Direct Current Motors

Machinery of any kind requires care and adjustment to get it into smooth running order, and this applies with especial force to continuous current motors. Even if the maker has carefully tested and adjusted it before shipment, as is customary, it is possible that the motor may have been mistreated in transit or has been improperly set up and adjusted.

If it has been changed in any way since leaving the factory the motor should be closely watched when first started, and new machines should have the bearings well oiled and be run for two or three hours with light loads or no load until everything looks right. After the motor is in good running order it should require no attention beyond cleaning, oiling and protection from overloads. The latter is of a special importance since overloading is the cause of most motor troubles. If the field coils and bearings are too hot to be touched with the bare hand there is danger, and the motor should be stopped instantly.

**Starting Rheostats.**

For machine shop work most stationary direct current motors are shunt wound because they must operate at definite speeds under variable loads on constant potential systems. The field coils of such motors are wound with fine wire, offering high resistance to the flow of current and reducing the quantity, and the field strength is constant because the voltage is practically constant. Hence, no trouble will probably occur, due to connecting the field coils to the circuit. The armature winding is made up of heavy wire or copper bars and the resistance is very low, being only about .2 ohms for a 10 horsepower 220 volt motor, so the rush of current at starting might be from 10 to 20 times normal full load current. The armature resistance is made low to get high efficiency and uniformity of speed. To reduce the starting current, a rheostat or "starting box" must be connected in series with the armature to introduce resistance into the circuit when starting the motor. The proper connections for motor starting rheostats are shown in Fig. 1, these being right for both shunt and compound wound motors.

An examination of the drawing will show that the field circuit is never opened by operating the rheostat. This not only prevents the injurious sparking which would take place, due to opening a circuit containing electromagnet coils, but also insures sufficient field excitation to enable the armature to generate a counter E. M. F. and reduce the rush of current from the line when the main switch is closed. The contact arm of the rheostat should be on the left-hand button of the dial when starting, in this case, and gradually moved to the right until held by the release magnet, shown on the right. This operation for starting the motor should take about 30 seconds and cuts out the resistance in series with the armature, thus allowing the motor to come up to full speed and generate sufficient counter E. M. F. to reduce the armature current to normal. Upon failure of voltage from the line the release magnet loses its power and a spring on the contact arm pushes it back to the starting position.

**Speed Regulation.**

Shunt wound d. c. motors run at practically constant speed on constant potential circuits, even with varying loads, the speed dropping only about 4 per cent in a 10 h. p. motor while increasing from no load to full load. The simplest way to reduce the speed of a shunt motor is to insert resistance in the armature circuit, reducing the current by "using up" the voltage in the resistance, and dissipating this energy in the form of heat. This is wasteful, since a large rheostat is required and the speed will vary considerly with the load unless the rheostat is adjusted as the load changes.

Another method is to vary the amount of flux or

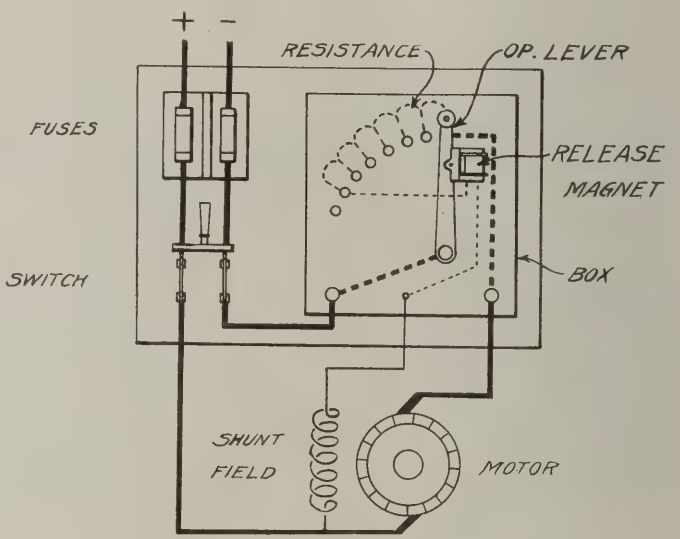



Fig. 1. Shunt Motor Connections

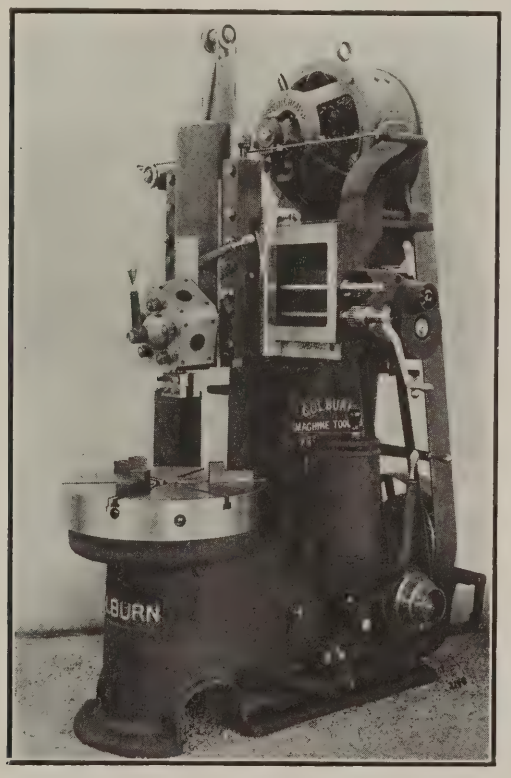
"lines of force" passing through the armature. An increase in the number of lines will reduce the speed and a decrease in the flux will cause the armature to speed up, so by inserting resistance in series with a properly designed field winding the strength of the field may be varied and the speed controlled. This is the method usually adopted because the current passing through the shunt field coil is very small, from 2 to 5 per cent of the armature current, and a smaller rheostat may be used. This has the disadvantage of causing increased sparking at the brushes on account of the weakened field at high speeds, so smaller torque must be expected of the motor when the speed increases. Hence, in order to give constant horsepower at any speed, the motor has to be made large enough to develop its full rating at high speed and will develop more at slow speeds. This accounts for the fact that variable speed shunt motors are so large in proportion to their capacity.

The multiple voltage system is sometimes used, the speed being in proportion to the voltage applied to the armature if the field strength be kept constant. This can be done by connecting the field coils across the outside wires of a three wire circuit and then connecting

the armature from middle to outside for slow speed and across the outside wires for high speed. Intermediate speeds must be obtained with resistances in the armature circuit. It will readily be seen that by having a large number of wires, with different voltages between them, a great range of speeds could be obtained. But this entails the use of complicated controlling devices for the motors.

### Series Motors.

For cranes, elevators, motor cars, etc., series motors are used because of their high starting torque. Their speed is controlled by means of a resistance inserted in series with them on the main circuit. This must be bulky and of the same current carrying capacity as the motor and line. Speed reduction is obtained at the cost of the energy dissipated in the rheostat. If two motors are used together, as on yard locomotives or motor cars. it is customary to start with them in series and later connect them in parallel for higher speeds. When in series the speed will be reduced one-half, because each motor receives half voltage, if the torque be kept the same.




Small Boring Mill with Individual Motor Drive

Compound wound motors are also used for elevators and hoists because they possess many characteristics of series motors. They are motors with both series and shunt field coils and the speed varies less with the load than in series motors.

They are operated like shunt motors by means of rheostats. Drum controllers are used for cutting in and out the resistance sections of the rheostats for machine tool motors of over 3 h. p. because they are more rugged and better protected than plain starting boxes, although large sized boxes are made for some purposes.

## PLANS FOR THIS SECTION.

As mentioned in the editorial columns the plans for this section include a series of articles descriptive of and co-ordinating the leading electrical railroad shop installations of the country. These articles are to begin in the May issue, and will follow the order in which the installations were made. The end in view is to have so complete and concise a set of descriptions that from a reading of them it will be possible to obtain a clear, accurate view of the history and development of electrical operation of railroad shops.

## INDIVIDUAL MOTOR DRIVE FOR SMALL BORING MILL.

All manufacturers of machine tools have begun to modify their designs to include the individual electric motor as an integral part of the machine. Many manufacturers have made radical changes to secure the best results from the use of the motor. One of the latest designs that includes a motor is illustrated; it is the 30-inch vertical boring mill with a Westinghouse adjustable speed direct current motor.

The motor is mounted on a bracket at the top of the machine, thus raising the motor out of the way, so that there is no chance for the metal chips to fall into the motor, as when the motor is located on the floor. The motor is belted to a friction clutch pulley, which replaces the core pulley used with belt drive. The clutch is controlled by a lever, so that the machine itself may be shut down without stopping the motor if but a short stop is to be made.

A 4-horsepower adjustable speed Westinghouse type "SA" direct current motor with a speed range of 400 to 1,600 r. p. m. is used, and its speed is controlled by a Westinghouse drum type machine tool controller with sixteen speed notches.

The machine can take work 32 inches in diameter and 16 inches in height, where a chuck is used, and 17 inches with the plain table. The table speed ranges in sixteen steps from 3 to 106 revolutions per minute. The turret slide has a vertical travel of 21 inches and may be set at any angle up to 30 degrees on either side of the vertical. A graduated scale attached to the slide is provided to indicate the depth of holes, etc.

The five-sided turret has holes 2¼ inches in diameter and also ⅝-inch tapped holes for attaching special tools. In addition to the regular clamping device for the tool holder shanks, special provision is made to keep the tool holders from twisting under heavy cuts. The lock bolt is of hardened steel ground perfectly true, and works in a hardened and ground steel index ring. Taper gibs of special design allow any wear in the lock nut to be easily and quickly taken up, thus keeping the turret holes in perfect alignment with the main spindle.

A friction brake operated by foot power permits the ready stopping of the machine with the table in any desired position.

The mill is made by the Colburn Machine Tool Company, Franklin, Pa.

## W. H. BEATTYS LEAVES WESTINGHOUSE CO.

W. H. Beattys, the well known and popular railroad representative of the Westinghouse Electrical & Manufacturing Company in Chicago, resigned on March 1st to take the position of manager of the Chicago office of the National Brake & Electric Company, of Milwaukee, Wis. This company makes a specialty of electrically operated air compressors for use in operating air brakes on electric cars. His place with the Westinghouse company has been taken by Mr. Tarkington, formerly of the Pittsburg office

# The Dope Sheet

*WIRE DATA—TRANSMISSION EQUIVALENTS.*

*Lead Covered Cable.*
.060 Capacity.

1 mile 22 = 1.41 mile No. 19
1 mile 16 = 0.70 mile No. 19
1 mile 14 = 0.56 mile No. 19
1 mile 13 = 0.53 mile No. 19

*Open Copper Wire.*
(In terms of .060 capacity. No. 19 Cable).

1 mile No. 19 cable = 30.5 mile No. 8 B.W.G.
1 mile No. 19 cable = 13.4 mile No. 12 N.B.S.
1 mile No. 19 cable = 8.0 mile No. 14 N.B.S.

*Open Copper and Iron Wire.*
(In terms of No. 8 B.W.G. copper).

| | Miles of line to 1 mile No. 8 B.W.G. |
|---|---|
| No. 8 B.W.G. copper | 1.00 |
| No. 12 N.B.S. copper | .46 |
| No. 14 N.B.S. copper | .28 |
| No. 6 B.W.G. (BB) iron | .20 |
| No. 8 B.W.G. (BB) iron | .16 |
| No. 10 B.W.G. (BB) iron | .14 |
| No. 12 B.W.G. (BB) iron | .11 |
| No. 14 B.W.G. (BB) iron | .08 |
| No. 19 B. & S. cable (.072 mf.) | .03 |
| No. 9 B. & S. copper | .54 (estimated) |

MAXIMUM LINE TRANSMISSION.

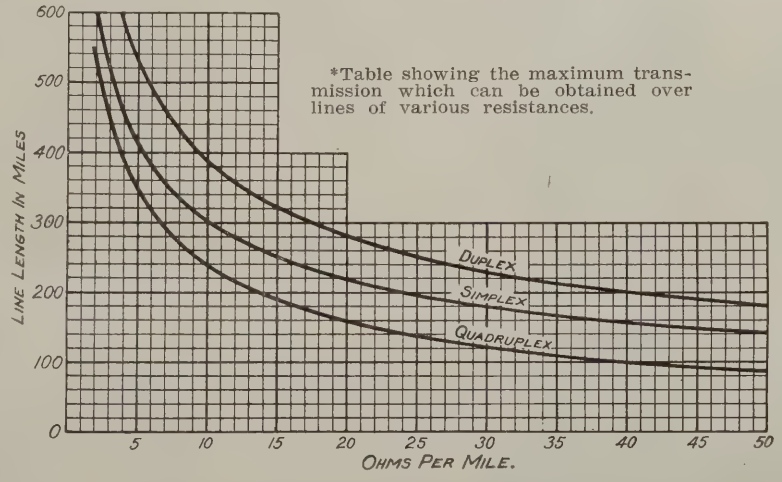



*Table showing the maximum transmission which can be obtained over lines of various resistances.

*From report of F. F. Fowle to Du plex Metals Company.

**TELEPHONES,** TRAIN DISPATCHING

SELECTOR RESISTANCE (OHMS) AT EACH STATION FOR CIRCUITS OF 5-30 STATIONS

| Station Number | Number of Stations: 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 | 28 | 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 420 | 630 | 882 | 1186 | 1522 | 1900 | 2320 | 2782 | 3830 | 5048 | 6434 | 7988 | 9710 | 11600 | 13658 | 15884 | 18278 |
| 2 | 252 | 420 | 630 | 882 | 1186 | 1522 | 1900 | 2320 | 3284 | 4418 | 5720 | 7190 | 8828 | 10634 | 12608 | 14750 | 17060 |
| 3 | 126 | 252 | 420 | 630 | 882 | 1186 | 1522 | 1900 | 2782 | 3830 | 5048 | 6434 | 7988 | 9710 | 11600 | 13658 | 15884 |
| 4 | 42 | 126 | 252 | 420 | 630 | 882 | 1186 | 1522 | 2320 | 3284 | 4418 | 5720 | 7190 | 8828 | 10634 | 12608 | 14750 |
| 5 | 0 | 42 | 126 | 252 | 420 | 630 | 882 | 1186 | 1900 | 2782 | 3830 | 5048 | 6434 | 7988 | 9710 | 11600 | 13658 |
| 6 | ... | 0 | 42 | 126 | 252 | 420 | 630 | 882 | 1522 | 2320 | 3284 | 4418 | 5720 | 7190 | 8828 | 10634 | 12608 |
| 7 | ... | ... | 0 | 42 | 126 | 252 | 420 | 630 | 1186 | 1900 | 2782 | 3830 | 5048 | 6434 | 7988 | 9710 | 11600 |
| 8 | ... | ... | ... | 0 | 42 | 126 | 252 | 420 | 882 | 1522 | 2320 | 3284 | 4418 | 5720 | 7190 | 8828 | 10634 |
| 9 | ... | ... | ... | .... | 0 | 42 | 126 | 252 | 630 | 1186 | 1900 | 2782 | 3830 | 5048 | 6434 | 7988 | 9710 |
| 10 | ... | ... | ... | .... | .... | 0 | 42 | 126 | 420 | 882 | 1522 | 2320 | 3284 | 4418 | 5720 | 7190 | 8828 |
| 11 | ... | ... | ... | .... | .... | .... | 0 | 42 | 252 | 630 | 1186 | 1900 | 2782 | 3830 | 5048 | 6434 | 7988 |
| 12 | ... | ... | ... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 | 2320 | 3284 | 4418 | 5720 | 7190 |
| 14 | ... | ... | ... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 | 2320 | 3284 | 4418 | 5720 |
| 16 | ... | ... | ... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 | 2320 | 3284 | 4418 |
| 18 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 | 2320 | 3284 |
| 20 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 | 2320 |
| 22 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 | 1522 |
| 24 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 | 882 |
| 26 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 | 420 |
| 28 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 0 | 126 |
| 30 | ... | ... | ... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... | 0 |

5 miles between stations.
No. 9 B. & S. Gauge 210 lb. Copper Wire.
Operating current .01 ampere.

**WIRE, COPPER**

Size, Weight, Resistance and Cost per Mile of BARE SOLID CONDUCTOR
No Allowance for **Sag** and **Waste**

| Size B. and S. | Diameter Mils. | Pounds per Mile. | Ohms per Mile. | COST PER MILE AT 12c. TO 18c. PER POUND: 12c | 13c | 14c | 15c | 16c | 17c | 18c |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 324.860 | 1683.6 | .51937 | $202. | $219. | $236. | $253. | $270. | $287. | $304. |
| 1 | 289.300 | 1335.2 | .65490 | 160. | 174. | 187. | 201. | 214. | 227. | 241. |
| 2 | 257.630 | 1058.8 | .82582 | 127. | 138. | 149. | 159. | 170. | 180. | 191. |
| 3 | 229.420 | 839.68 | 1.0414 | 101. | 109. | 118. | 126. | 135. | 143. | 151. |
| 4 | 204.310 | 665.91 | 1.3131 | 80. | 87. | 93. | 100. | 107. | 113. | 120. |
| 5 | 181.940 | 528.05 | 1.6558 | 63. | 69. | 74. | 79. | 84. | 90. | 95. |
| 6 | 162.020 | 418.81 | 2.0881 | 50. | 55. | 59. | 63. | 67. | 71. | 76. |
| 7 | 144.280 | 332.11 | 2.6331 | 39.85 | 43.17 | 46.49 | 49.81 | 53. | 56. | 60. |
| 8 | 128.490 | 263.37 | 3.3201 | 31.56 | 34.19 | 36.82 | 39.45 | 42.08 | 44.71 | 47.34 |
| 9 | 114.430 | 208.88 | 4.1860 | 25.06 | 27.15 | 29.23 | 31.32 | 33.41 | 35.50 | 37.59 |
| 10 | 101.890 | 165.63 | 5.2800 | 19.92 | 21.58 | 23.24 | 24.90 | 26.56 | 28.22 | 29.88 |
| 11 | 90.742 | 131.37 | 6.6568 | 15.75 | 17.06 | 18.37 | 19.68 | 21.01 | 22.32 | 23.64 |
| 12 | 80.808 | 104.18 | 8.3940 | 12.48 | 13.52 | 14.56 | 15.60 | 16.64 | 17.68 | 18.72 |
| 13 | 71.961 | 82.632 | 10.585 | 9.91 | 10.73 | 11.56 | 12.38 | 13.21 | 14.04 | 14.87 |
| 14 | 64.048 | 65.674 | 13.347 | 7.92 | 8.58 | 9.24 | 9.90 | 10.56 | 11.22 | 11.88 |

# "National" STORAGE BATTERIES

THE STANDARD BATTERY FOR CAR LIGHTING SERVICE

ANY CAPACITY
ANY TYPE
ANY METHOD
OF ASSEMBLY

C. L. A.—15 ASSEMBLED IN TWO-COMPARTMENT LEAD-LINED TANK

# BLISS - SYSTEM - MOSKOWITZ

## ELECTRIC TRAIN LIGHTING

## ECONOMY RELIABILITY EFFICIENCY

These three all-important considerations are thoroughly demonstrated in the **"Bliss"** and **"Moskowitz"** Systems of Electric Car Lighting. Actual figures obtained from operating conditions on a large number of railroads indicate conclusively the superior advantages of these two Systems over all others.

PERFECT REGULATION and LOWEST OPERATION COSTS are assured to the purchaser.

**Communicate with nearest office for complete information.**

## The United States Light and Heating Co.

**General Office: 30 Church St., New York**

"Bliss System of Electric Car Lighting." "National" Batteries. "Moskowitz System of Electric Car Lighting."

NEW YORK CHICAGO BUFFALO CLEVELAND DETROIT ST. LOUIS BOSTON SAN FRANCISCO

# General News and Personal Mention

## RAILWAY APPLIANCES EXHIBITORS.

The week of March 20 will see the annual exhibit at the Coliseum of manufacturers of railway appliances. These cover such an extensive field that not all of them will be of interest to any one man. Among those which will catch the eye of the electrical man are the following:

Adams & Westlake Company.
Kerite Insulated Wire & Cable Company.
Okonite Company.
Edison Storage Battery Company.
Electric Storage Battery Company.
General Electric Company.
Western Electric Company.

And incidentally we will be there ourselves—"with bells on," to resuscitate an old slang phrase.

## WORTH TWICE AS MUCH AS GOLD.

In 1905 platinum sold as low as $18.50 per ounce, and even at that figure, was not in great demand. Today it is selling for $43.00 per ounce, a truly astonishing figure, when the price of gold, about $22.00 per ounce is considered. The great increase in the manufacture of incandescent lamps is the principal cause for the advance in price.

The Diamond Rubber Company of Akron, Ohio, has recently entered upon a campaign for the sale of its rubber covered wire. Sales Agencies covering practically the entire country have been placed. This company also manufacturers rubber belting and other rubber products.

The Federal Electric Company, Chicago, Ill., has recently completed arrangements whereby the Federal Sign System will take charge of the sales of all its products. These consist of signs, vacuum cleaners, magnetic sockets, tungsten clusters and numerous other specialties. The Federal Sign Company has offices in the Home Insurance Building, Chicago, and at 229 W. 42nd street, New York City, with branches in 14 other large cities. The selling force will be augmented by the former representatives of the Federal Electric Company.

The card index idea is carried to its ultimate conclusion in a little magazine called *Data*, recently put before the engineering public. This is like no magazine ever before seen. It consists of 3 x 5 cards bound so as to be cleanly detachable. Each card contains data on some engineering subject and is complete in itself. The magazine is issued monthly, the subscription price being one dollar a year. It is understood that *Data* is receiving a very flattering reception from engineers in all branches of work. The magazine is published in Chicago.

The Sangamo Elec. Co., Springfield, Ill., have just made a large shipment of integrating Mercury Flotation Watt-hour meters to Manila, Philippine Islands. Owing to the long shipping distance involved it was important that a type of meter be selected that would withstand rough usage wihout injury and the Mercury Flotation Type was judged by the Purchasing Engineers to be particularly well adapted to meet the conditions. This is another instance where American made products are successfully competing with the Foreign Designs.

## DOUBLE BELT AXLE DRIVE.

Belt troubles are evidently not peculiar to American car lighting, for it is an Englishman, Mr. A. A. Crawford, of Bombay, India, who has invented and patented the double belt arrangement shown in the accompanying patent drawing. Each belt is strong enough to carry the full load on the dynamo so that the breaking

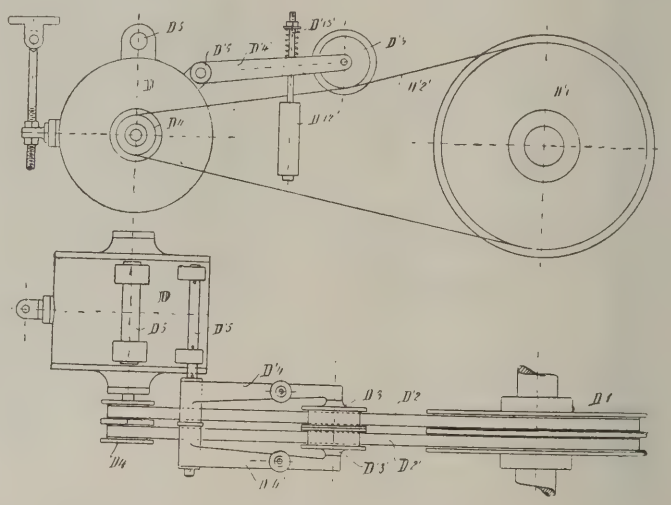


Diagram of Double Belt Axle Drive

of either will not cause a light failure. The tension on each belt is secured by an independent jockey pulley which is so constructed as to be self lubricating. The pressure of these pulleys is caused by a weight and regulated by a spring.

Mr. A. J. Sweet is making a special study of electric lighting on railways for the Holophane Company. The results of this investigation will be used as a basis for the design of special railway reflectors.

The American Pulley Company, Philadelphia, Pa., has recently issued a circular on axle lighting pulleys and bushings manufactured by them. Attention is called to the fact that the pulleys conform to the standard specifications adopted by the Association of Railway Electrical Engineers.

B. F. Fuller, formerly in the electrical department of the C. & N. W. Railway, is now occupying the position of assistant sales engineer for the J. Lang Electric Company of Chicago, designers and builders of switchboards. This company has done a large business with the railways.

Roth Brothers & Company, Chicago, Illinois, have recently issued a catalog showing some of the many uses to which Roth motors are being put. These include blowers, saws, presses, and many other kinds of small machinery.

Mr. J. M. Schilling has resigned from the position of Chicago Manager for the Westinghouse Lamp Company to engage in private enterprise. His place has been taken by Mr. D. F. Harris.

# A Few Very Strong Arguments in re. The SALOM RAILWAY BATTERY--Not Fiction

## THE SALOM BATTERY is the greatest improvement in Storage Batteries in Thirty Years.

¶ By the Salom process the active material is formed and then applied under enormous pressures to the grid or contacting support. This method allows for all expansion and contraction of the active materials while they are being formed in bulk before it is placed into the grid. This method eliminates all the faults of the lead battery and results in much longer life and higher efficiency and voltage. The resistance between the active material and the grid is less than the Plante plate, due to the material being placed in such perfect contact with the supporting grid. This means higher voltage and better efficiency.

The positive plates cannot grow like the Plante plate because there is no further expansion of the active material and no lead to be converted into active material.

The negative plate cannot shrink, as there is no space left in the grid that is not filled with active material, and it cannot wash away because the Salom process produces a porus sheet of spongy lead and an antimonial lead grid for the support. The ideal condition that all battery manufacturers have strived for years to attain.

The antimonial lead is not acted upon by an electric current and the life of the plate is indefinite.

We can show you a saving in the maintenance of your present lighting equipment that will pay for the complete installation of the Salom Storage Batteries on your lines, giving you a larger factor of saving in your lighting equipments, reduce the force of operators in maintaining them and less expenditure for renewals than any other battery.

Send to Department G for a copy of the paper entitled, "Evolution of the Lead Storage Battery," read by Mr. Pedro G. Salom before the Electro Chemical Society of Chicago on October 14,1910. Instructive literature and complete details will be sent at your request by addressing us at one of the following offices:

## NIAGARA LEAD & BATTERY CO.

MAIN OFFICE AND FACTORY :: NIAGARA FALLS, NEW YORK

CHICAGO: 150 Michigan Ave. PHILADELPHIA: 333 Walnut St. NEW YORK: 113 West Twenty-Fifth St.

## BOILER SCALE PREVENTION BY ELECTRICITY.

A method of boiler scale prevention based upon a theory which will probably be new to many was described by Thos. R. Duggan at the last meeting of the New York Section of the Society of Chemical Industry.

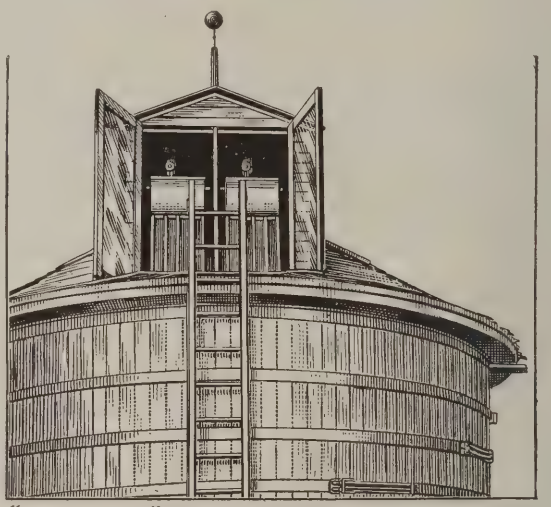
The method itself is very simple. It consists of allowing the water treated to run in a thin stream over aluminum plates properly corrugated. The passage of the water, according to the inventor, Herr Brandes, induces a slight current of electricity, the water being negative and the plates positive. The matter held in solution in water so treated is thrown down as a fine powder in the boilers. It does not form a hard crystalline crust, or scale, as it would otherwise have done. This powder may be blown out by steam without the use of chipping hammers or other removal apparatus.

The theory upon which the operation of this treatment is based is that the slight electric current causes ionization of the salts in solution to take place with the result that they do not take a crystalline form but become amorphous. The presence in the water of a small amount of aluminum in the colloidal form is also thought to have something to do with the action.

It is further claimed that water so treated greatly lessens corrosion or rusting of the inside of boilers.

The treated water must be used in boilers within seven days of its treatment. It has been found that the action takes place much more freely where the plates are exposed to light and air than where they are inclosed. The corrugation of the plates is for the purpose of causing an even flow of water.

The apparatus, called a "luminator," as arranged for use on a railroad water tank is shown in the accompanying cut.



"LUMINATORS" SET ON THE TOP OF A STORAGE TANK.

# Association Directory.

### ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....323 Kinzie St., Chicago.**

The next convention of the Association will be held in Washington, D. C., June 16th and 17th, 1911. The Annual Convention will be held at the La Salle Hotel, Chicago, Nov. 6-10, inclusive.

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H. G. Thompson, Edison Storage Batt. Co.
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# ELECTRICAL CONDUITS

SHERARDUCT NATIONAL METAL MOLDING CO. ECONOMY, PA.

Annealed, bends easier — smoothest interior, fishes easier—threads, sharp, clean-cut, rust-proof; no re-cutting necessary; perfect grounding.

The Rust-Proof, Non-Corrosive Conduit

ECONOMY NATIONAL METAL MOLDING CO. ECONOMY, PA.

Comprises all those features that pertain to the best in enameled conduit construction.

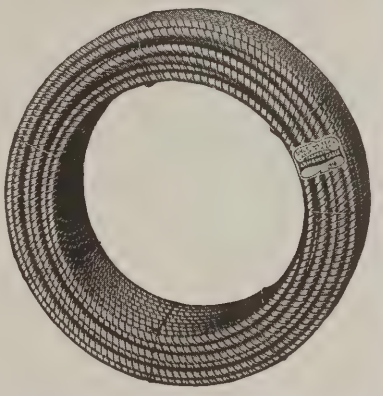
Enameled Iron Conduit

"NEW FLEXDUCT"
The Tube that Terminates Tube Troubles

## "NATIONAL" METAL MOLDING

FIRE-PROOF
NAIL-PROOF
RUST-PROOF

Artistic Appearance. Quickly and Easily Installed.



FLEXSTEEL Armored Conductors
Superior in Every Respect

All above regularly inspected and labeled under supervision of Underwriters' Laboratories. Send for samples and catalogs.

**NATIONAL METAL MOLDING CO., Pittsburgh, Pa.**

OFFICES. New York, N. Y. Boston, Mass. Atlanta, Ga. Detroit, Mich. Chicago, Ill Denver, Col. Salt Lake City, Utah. San Francisco, Cal.

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# OFFICIAL RECORDS

## OF ONE OF THE LARGEST ROADS SHOW REDUCED OPERATING COST AND INCREASED EFFICIENCY SINCE USING

# OLIVER BRONZE BEARINGS.

## THEY HAVE RENEWED THEIR CONTRACT FOR THE THIRD SUCCESSIVE YEAR.

# OLIVER ELECTRIC & MFG. CO.

## 2219 LUCAS AVE.

F. W. OLIVER
President

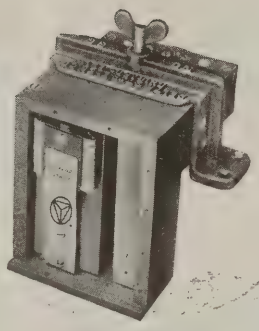
## ST. LOUIS, MO.

T. B. ENTZ
Manager

# DARK TRAINS ARE UNKNOWN

**On Any of the Roads Now Using Our New Train Connector with**

## Automatic Loop Switch



COVER REMOVED

**Nothing to Forget**

**Indispensable to First-Class Train Lighting**

**Fool Proof**

**INTERCHANGEABLE WITH GIBBS TYPE**

**DELTA-STAR ELECTRIC CO.**

**541-553 W. Jackson Boul. CHICAGO**

136 Liberty Street NEW YORK

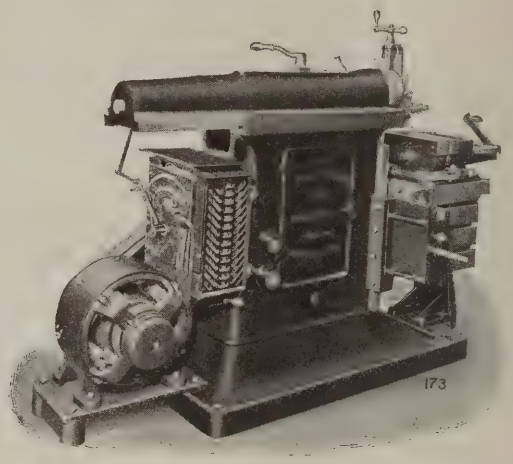
1388 W. Adams Street CHICAGO, ILL.

# ROTH MOTORS—

are easily attached to machine tools or any other forms of machinery.

BEARING BRACKETS can be turned around for wall or ceiling operation without disturbing the electrical connections.

Are RELIABLE in every way.



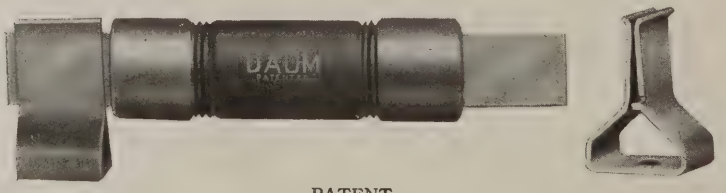
## Roth Bros. & Co.

1388 W. Adams St. CHICAGO, ILL.

136 Liberty St. NEW YORK OFFICE

# IT IS NOT SUCH A SERIOUS MATTER

If a fuse does blow in a car which is standing in the yards. You can get another one. But what if the car is out in the wilds—miles from the nearest repair point? What are you going to do then? Let it go dark? Not if you value your job. Carry a full supply of fuses? Not if you like to run your department economically. What then? Use the




PATENT

# Daum Refillable Fuse Shell

and a few fuse wires. You can repair the damage in a few minutes at practically no expense.

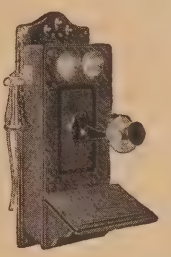
Ask us some more about it. We'll be tickled to tell you. Or ask Mr. Willis C. Squire, in the Western Union Building in Chicago. He's our Western Agent.

**A. F. DAUM MFG. CO., - Pittsburgh, Pa.**

# "THE NERVES OF YOUR SERVICE"
## THE CHARACTER OF YOUR COMMUNICATION

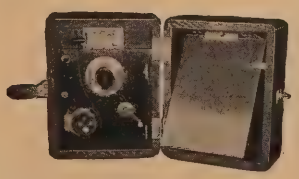
Did you ever think of it in that way? That, with the ever widening use of the telephone not only in train management, but in the control of that wonderful organization—the modern railroad system—each telephone approaches in importance to the usefulness and reliability of each man-unit; from freight clerk to official, from train man to dispatcher.

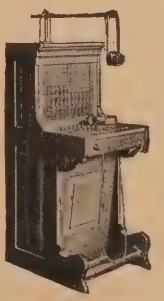
His voice is its voice. In emergency his value is its value. Its operation is his intelligence. Do they fail you? Almost never. How the power of the man *widens* at the click of the switchhook. Four fold his value increases with the *worth* of the telephone at his control.



While its appearance reflects its builder, its service reflects the system it serves, the men who control it. When you talk of railway telephones today—your subject is as important to modern railroading, as nerves are to the men in control. Would a man's brain be of use without nerves?

Then buy your telephones for their worth—not their price. Kellogg telephones are sold for their worth. Let us tell you in detail why.





**KELLOGG SWITCHBOARD & SUPPLY CO.**

**CHICAGO**

# "AXLE LIGHT"

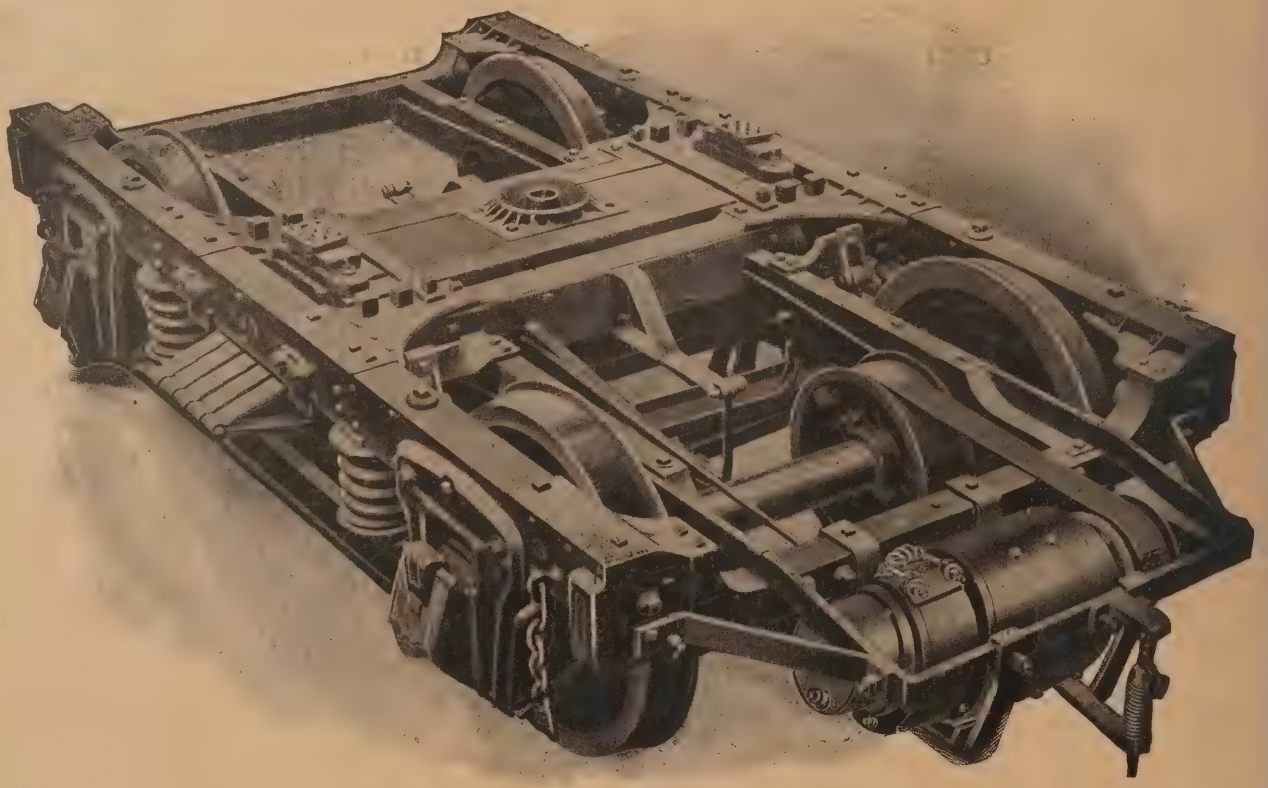
TRADE MARK
Reg. U. S. Patent Office

THE SIMPLEST AND MOST EFFICIENT.

LOWEST COST OF OPERATION.

**EVERY EQUIPMENT GUARANTEED.**

**Regulating device for both Dynamo and Lamps concentrated in one machine**



## Consolidated Railway Electric Lighting & Equipment Co.

General Offices
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Western Offices
1720 MICHIGAN AVE., CHICAGO, ILL.

RANK & GOODALL, Agents, 801 Pioneer Press Bldg., ST. PAUL MINN.

RAIL

FIRST ARTICLE OF RAILWAY SHOP SERIES IN THIS ISSUE

# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED THE

Electric Trunk Line Age

The Official Journal of the Association of Railway Electrical Engineers

Vol. 2 | CHICAGO 106 N. La Salle Street | MAY, 1911 | $1.00 per year Domestic—$1.50 per year Foreign 10 Cents per Single Copy | No. 12

[NEW PENNSYLVANIA TERMINAL, NEW YORK CITY

In this, the largest railway passenger terminal in the world, Kerite insulated wires and cables are used in the entire signal installation, in the lighting of the Hudson and East River Tunnels, in the storage battery charging plants for car lighting, etc.

DAYS KERITE

**Kerite Insulated Wire & Cable Co.**

*Incorporated by W. R. BRIXEY*

GENERAL OFFICES

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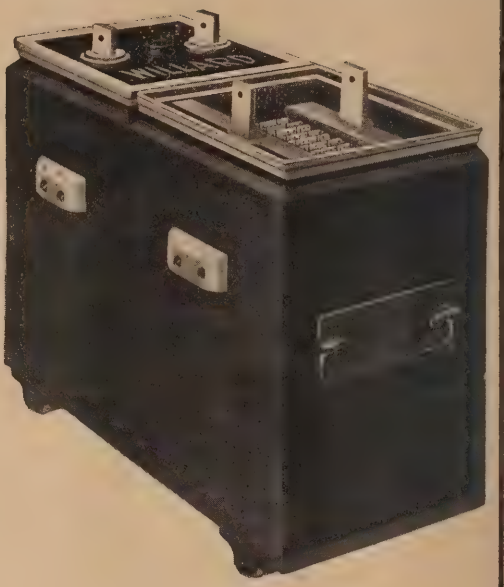
DAYS KERITE

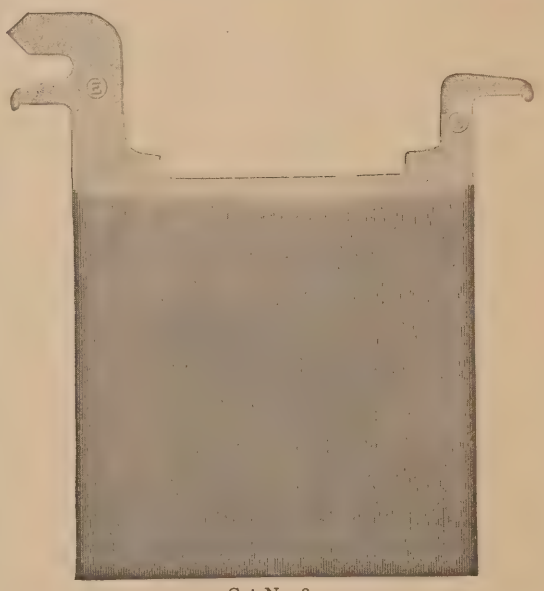
# THE WILLARD TRAIN LIGHTING BATTERY



Cut No. 1

## OVER 100,000 CELLS IN USE

***Write for Bulletins No. 31 and No. 32***



Cut No. 2

# THE WILLARD SIGNAL BATTERY

Conforms in every detail to Signal Association's Standard

***Write for Bulletins No. 29 and No. 34***

## Construction

Absolute uniformity in the thickness of raised portions gives a perfectly even distribution of current over all the surface of the plate.

Correct proportioning of active surface.

AMPLE RESERVE lead in active portion.

## Result

***Freedom From Buckling***

***Maintained Capacity***

***Long Life***

TOTAL RESULT of these distinctive features together with 19 years experience in battery making—

***Low Maintenance Cost and Reliability In Service***

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**CLEVELAND, OHIO**

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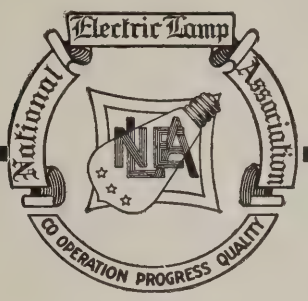
CHICAGO, ILL.

227 JEFFERSON AVE.
DETROIT, MICH.

136 WEST 52nd ST.
NEW YORK




In the effort to supply **the** lamp best adapted to the different problems of electric lighting, the member companies of the National Electric Lamp Association, by co-operative effort, have set the pace of progress and at the same time maintained the highest standard of quality.

Over half a million dollars are spent annually to maintain the slogan of the Association by

**Co-operation** along technical and commercial lines.

**Progress** in the support of an Engineering Department equipped with research and development Laboratories

**Quality** in expert supervision and testing of the product of each of the factories of the member companies.

To assure the best lamp value, buy lamps from any of the following member companies of the

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**CLEVELAND**

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The Buckeye Electric Company, Cleveland, Ohio
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Monarch Inc. Lamp Co., Chicago, Ill.
Shelby Electric Co., Shelby, Ohio
Sunbeam Inc. Lamp Co., N. Y. City Chicago, Ill.

The Brilliant Electric Company, Cleveland, Ohio
The Buckeye Elec. Lamp Co., S. A. Mexico, D. F.
Columbia Inc. Lamp Co., St. Louis, Mo.
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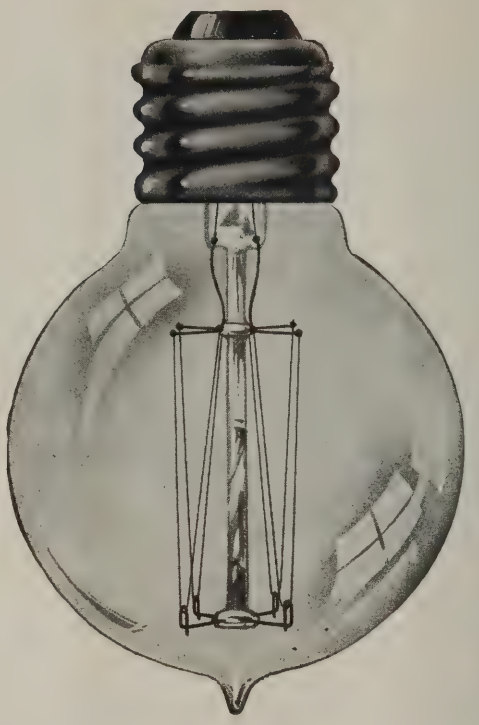
Warren Elect. & Specialty Co. Warren, Ohio

THE
# BUCKEYE
MAZDA
TRAIN LIGHTING LAMP

embodies all the highest qualities to be found in any lamp. It is the result of a most careful study into the train lighting proposition and has been carefully designed to meet the special requirements of this service.

WE SOLICIT YOUR ORDER



THE BUCKEYE ELECTRIC CO.
MAIN OFFICE AND WORKS, CLEVELAND, OHIO

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SIGNAL WIRE CAR WIRE
To Meet the Most Exacting Specifications

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COPPER CLAD WIRE
Bare and Insulated
For All Forms of Railway Service

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25% more current
Big brand new fields of usefulness for the new kind of storage battery are opened up by the
SALOM ELECTRIC STORAGE BATTERY
It has proved 25% greater capacity in competition with other batteries, and it lasts twice as long, besides.
Write for Booklet that explains clearly the different construction of the Salom Battery
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DEPT. G
NIAGARA FALLS, N. Y.
NEW YORK PHILADELPHIA CHICAGO

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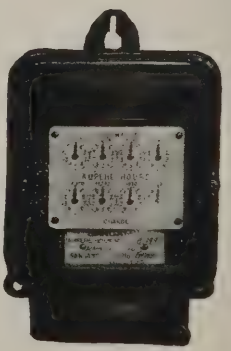
|---|---|
| Battery Depreciation annually without ampere-hour meter (18% of $700) | $126.00 |
| Battery Depreciation annually with ampere-hour meter (14% of $700) | 98.00 |
| **Ampere-hour meter saving per year** | **$ 28.00** |

*You can save, in one year, considerably more than the cost of the meter.*

Sangamo Electric Company ∴ Springfield, Ill.



Sangamo Duplex Train Meter

# QUALITY MAINTAINED
# QUANTITY INCREASED
# MODERATE PRICES

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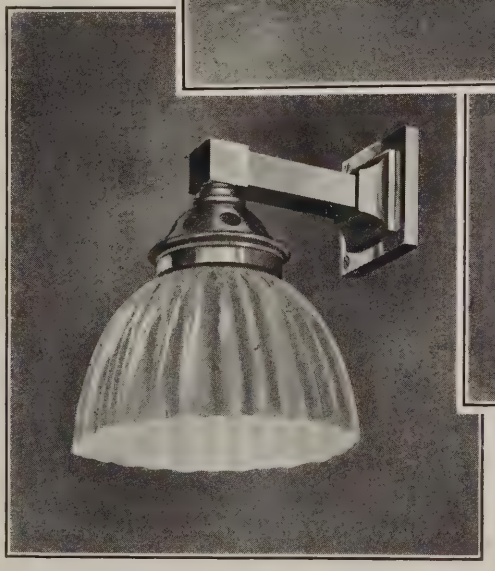
**1 Light Pendant No. 8185**

**2 Light Bracket No. 8184**



**1 Light Bracket No. 8183**

**Shades No. 9011**

The faith we have in the proved mechanical, artistic and illuminating superiority of these fixtures, justifies our belief in large sales at attractive prices.

We have decided to make up and hold for future delivery sufficient quantities of these fixtures to warrant expensive manufacturing tools.

The cost of these tools will be absorbed by the decreased manufacturing costs and we are in a position to supply a standard line of fixtures with quality maintained and at a low cost.

Write us for particulars

**THE SAFETY CAR HEATING AND LIGHTING CO.**
**2 RECTOR STREET, NEW YORK**

It costs less to pay the higher first cost and buy

# The Edison Storage Battery

for railway train lighting, either straight storage or axle generator system, than to accept lead battery equipment free of first cost.

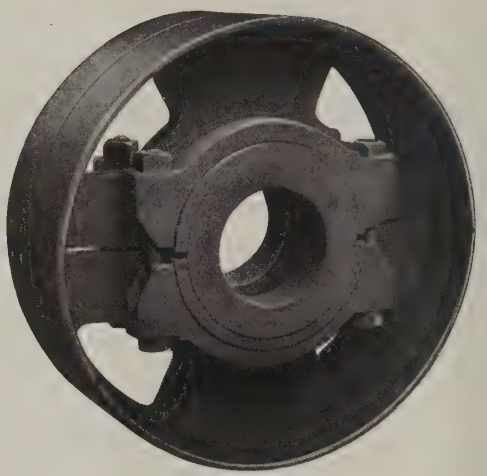
The reason is that the lead battery weighs about four times as much as the Edison and it's the expense of hauling around this extra weight that runs up the cost of lead battery equipment far beyond that of the Edison.

Add to this the fact that *you do not get lead battery equipment free of first cost.* And also that the Edison requires far less care and attention, is subject to none of the ills of the lead battery and lasts many times as long.

Ask us to go into detail and give you complete figures on it.

**Edison Storage Battery Co.**
**120 Lakeside Avenue**
**ORANGE, N. J.**

# The "AMERICAN" SPECIAL PULLEY



(Patented)

## For Railway Car Electric Lighting

While this pulley is made to meet the special demands of electric car lighting, its general principles are not different from the **World-famous** "American" Belt Pulley.

It has been pronounced by experts the best of its kind. This is but natural as it is the "first cousin" to the "American" Wrought Steel Pulley.

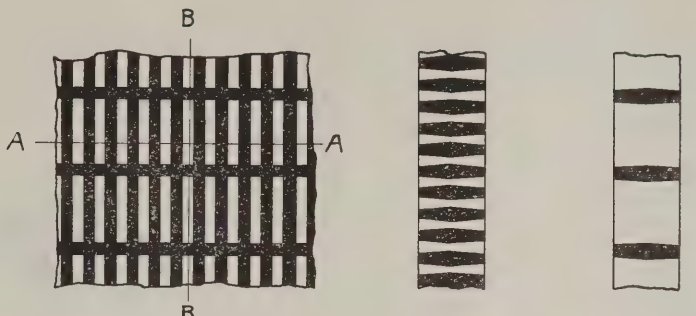
It is a parting pulley:—light, strong, easily put on or taken off, indestructible, accident proof.

Write for more explicit information. We will cheerfully send you our complete catalog showing the full line of our standard belt pulleys. Made in sizes 6 inch to 60 inch diameter: 2 inch to 36 inch face. Also made in sizes intermediate to those listed.

**THE AMERICAN PULLEY COMPANY**
**MAIN OFFICE AND WORKS, PHILADELPHIA, U. S. A.**
**CHICAGO BRANCH, 124 S. CLINTON ST.**

# The "Tudor" Positive Plate Insures Long Life

## For Car Lighting Service




Enlarged view of a section of a "Tudor" Positive Plate — Section at AA — Section at BB

Of all the various forms of Plante type of plate construction, the "Tudor" Positive Plate has the distinction of possessing the greatest mechanical strength.

Its special features are: An exact proportioning of ribs; the distinctive feature of the through and through circulation of electrolyte; the reinforcing features made possible by its type of construction: the large amount of reserve lead in the ribs.

The plate structure is such as to give strength, to minimize growth and buckling, to decrease sediment—resulting in long life.

# THE ELECTRIC STORAGE BATTERY CO.

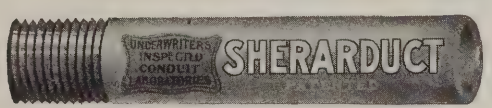
1888 PHILADELPHIA, PA. 1911

NEW YORK BOSTON CHICAGO ST. LOUIS CLEVELAND ATLANTA DENVER DETROIT SEATTLE LOS ANGELES SAN FRANCISCO PORTLAND, ORE. TORONTO

# ELECTRICAL CONDUITS

SHERARDUCT — NATIONAL METAL MOLDING CO. ECONOMY PA

Annealed, bends easier — smoothest interior, fishes easier—threads, sharp, clean-cut, rust-proof; no re-cutting necessary; perfect grounding.




The Rust-Proof, Non-Corrosive Conduit

ECONOMY — NATIONAL METAL MOLDING CO. ECONOMY PA

Comprises all those features that pertain to the best in enameled conduit construction.

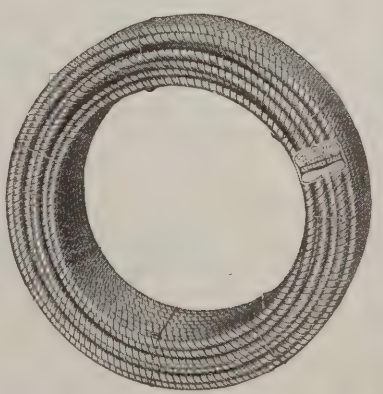
Enameled Iron Conduit

**"NEW FLEXDUCT"**
The Tube that Terminates Tube Troubles

## "NATIONAL" METAL MOLDING

FIRE-PROOF
NAIL-PROOF
RUST-PROOF

Artistic Appearance. Quickly and Easily Installed.



**FLEXSTEEL Armored Conductors**
Superior in Every Respect

All above regularly inspected and labeled under supervision of Underwriters' Laboratories. Send for samples and catalogs.

**NATIONAL METAL MOLDING CO., Pittsburgh, Pa.**

OFFICES. New York, N. Y. Boston, Mass. Atlanta, Ga. Detroit, Mich. Chicago, Ill Denver, Col. Salt Lake City, Utah. San Francisco, Cal.

All above regularly inspected and labeled under supervision of Underwriters' Laboratories. Send for samples and catalogs.

*Lake Shore & Michigan Southern Standard*

# MAKING A STIR

is commonly supposed to be the only function of a fan. However important this function may be, it is not the only thing that a fan should do.

When installed in the ceiling of a car

# THE JANDUS GYROFAN

draws in a steady stream of pure, fresh air and distributes it equably throughout the body of the car. Ventilation is perfect and positive at all times and is independent of the speed of the train or outside atmospheric conditions.

The Jandus Gyrofan is more than a fan—it is a scientific ventilator. It is being used on the best trains of the best railways. It is the best, the handsomest, the most scientific of all breezemakers.

Write us your conditions, we can help you.

## THE ADAMS-BAGNALL ELECTRIC COMPANY

**CLEVELAND**

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Chicago

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Pittsburg
Montreal

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## Engineers

Design and install ELECTRIC DRIVES and ELECTRIC POWER PLANTS for railways.

TRUNK LINE ELECTRIFICATION WORK is our strong suit.

Our exceptional experience enables us to make use of various improvements not thought of by others.

We design equipments so low in first cost and so high in efficiency as to make electric motive power an economical factor in many cases, where it was previously considered a luxury.

Give us a chance at one of your problems!

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NEW ENGINEERING BUILDING : : ANN ARBOR, MICH.

TRADE COMMERCIAL MARK
STORED SUNLIGHT
ACETYLENE

## IS THE BEST AUXILIARY

**THE popularity of electric car lighting depends to a certain extent upon a satisfactory auxiliary. The question is, what is the most satisfactory auxiliary light? Candles are used on some cars when the electric lights fail, and on others, oil lanterns. Such auxiliaries can hardly be called satisfactory. The traveling public demands a good light when electricity fails.**

**COMMERCIAL ACETYLENE furnishes such a light economically. A small tank, 12 inches in diameter by 36 inches long, contains sufficient gas to supply an auxiliary light for weeks. There is no deterioration, and nothing to get out of order.**

**Booklet "C" on request.**

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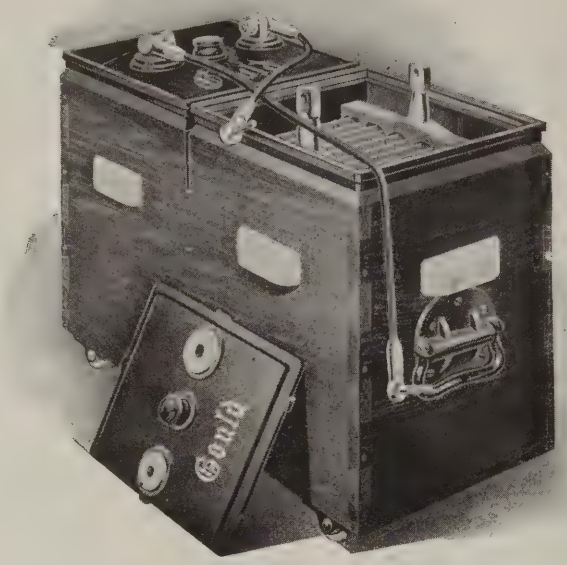
**80 BROADWAY, NEW YORK**

BRANCHES:

CHICAGO BOSTON ATLANTA SAN FRANCISCO TORONTO

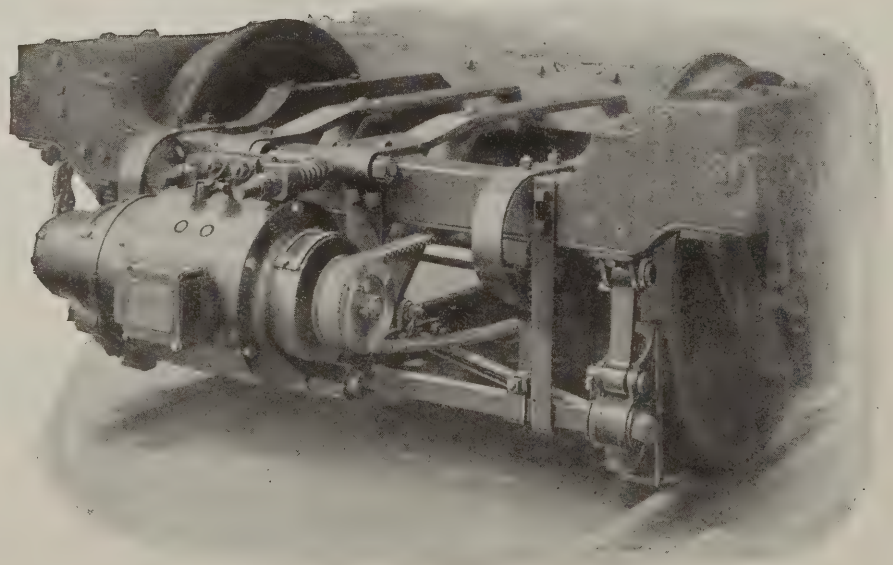
**Gould Storage Battery Company,** 341-347 FIFTH AVE., NEW YORK
THE ROOKERY - CHICAGO




GOULD CAR LIGHTING BATTERIES

GOULD
ELECTRIC CAR LIGHTING

GOULD AXLE SYSTEM OF LIGHTING



**GOULD COUPLER COMPANY,** 341-347 FIFTH AVE., NEW YORK
THE ROOKERY - CHICAGO

# RAILWAY ELECTRICAL ENGINEER

WITH WHICH IS INCORPORATED TH

Electric Trunk Line Age

Official Journal of the Association of Railway Electrical Engineers.

PUBLISHED MONTHLY BY

WRAY PUBLISHING CO.

EDWARD WRAY, President. J. G. WRAY, Sec. & Treas.

RALPH BIRCHARD, Manager.

106 N. LA SALLE ST.

CHICAGO

Telephone Main 2457.

Editors ..... Edward Wray, C. L. de Muralt, Geo. W. Cravens, Ralph Birchard

Entered as second-class matter, August 6, 1909, at the Post Office at Chicago, Ill., under the Act of March 3, 1879.

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TERMS OF SUBSCRIPTION

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OUR OBJECT.

**The object of this publication is to provide a medium for the free interchange of ideas and experience among those identified with the operation of electrical apparatus as applied to railway practice.**

**In this mutual exchange of ideas among the men prominent in the field there will result a better understanding and solution of the problems before us and a wonderful inspiration for all to greater achievements.**

## CONTENTS


EDITORIALS:

- The Shop Series ..... 239
- Car Lighting and Electric Traction ..... 239

Association News ..... 240
Car Lighting Club ..... 240
Car Lighting Cost Accounting ..... 240
Harriman Lines Electricians' Conference ..... 242
The Great Western's New Steel Train ..... 242
An Adjustable Headlight Reflector ..... 242

ELECTRIC TRACTION SECTION:

- Latest Data on Single Phase Operation ..... 244
- Detroit Tunnel Electrical Equipment ..... 245
- Electrification from the Operating Man's Point of View ..... 246
- Mr. L. C. Fritch on Electrification ..... 247
- Maintenance of Way Association Reports ..... 247
- Chicago Terminal Electrification Study ..... 247

THE SHOP SECTION:

- The Pullman Company's Shops ..... 248

Exhibits at the Railway Appliance Show ..... 252
Railway Telephony ..... 254
Telegraph and Telephone Train Dispatching ..... 256
The Dope Sheet ..... 257
General News and Personal Mention ..... 258
Association Directory ..... 12


### The Shop Series.

YOUR attention is asked for the opening article of the Shop Series, which appears in this issue. This series has been undertaken with the fixed idea and purpose of co-ordinating the shop practice of the railways of the United States as exemplified in twelve specific instances. It is our hope and desire that the reader who has finished the articles will have a clearer idea than he has ever had before of what is done and how it is done in the railway shops of this country, and that this knowledge will have been gained with the minimum expenditure of time and attention.

### Car Lighting and Electric Traction.

BECAUSE street cars are lighted directly from the motive power circuit it would seem natural to suppose that the coming of electric traction on trunk line railways would mean the disappearance of the electric car lighting equipment in use today. To some, of course, it will seem idle to speculate on the truth or falsity of this conclusion. To others, who see electric traction as a development of the immediate future and who are engaged in car lighting work, it is a very real and pressing question.

Will electrically propelled trains be lighted from the power circuit? The electrically propelled trains of today are not. True, the fact that these trains are electrically propelled through but a small fraction of their runs offers an immediate reason for the retention of the old equipment. But there are other reasons.

The consideration of safety is one of these reasons. Where the power circuit is operated at a pressure of more than 500 volts the use of this current in the lighting circuit becomes seriously dangerous. Contact with the first of five 100-volt lamps arranged in series would send a 500-volt current through the person making it, and fatal results would be almost sure to ensue.

Failure of one lamp in a circuit of this kind would put five lamps out of commission, with a possibility of dangerous arcing. Which brings out the second consideration, reliability. Passengers of a through train pay for and demand a better quality of service than is expected of a street railway.

But the strongest objection to the use of a power circuit is the difficulty and expense of securing a voltage regulation sufficiently close to give any satisfactory lighting results. On a street car line the traffic is relatively heavy. Train units are small and follow one another at short intervals. The effect upon the line voltage of the throwing in of the motors is slight. Even here the regulation is often poor, as witness the familiar dimming of the lights in a street car at the moment of starting. On a trunk line the distances between sub-stations are greater and the train units larger. The result is that midway between sub-stations the voltage falls off considerably, especially if a heavy motor load happens to be thrown in at these points. This drop in voltage may easily reduce the light to such an extent that the car is scarcely lighted at all. A drop of 15 per cent in the voltage reduces the light flux from a tungsten lamp one-half.

Another service objection is that every break in the contact (overhead or third-rail as the case may be) throws the car into darkness. These breaks are short and at high speeds would cause only momentary darkness. So short is this interval that no automatic switch at present used would act quickly enough to cut in auxiliary batteries. And if such batteries were used, either converters or motor-generator sets to charge them would have to be carried on the train, or terminal charging facilities provided, where alternating current is used for power.

These difficulties are so numerous and hard to overcome that it seems as if the manufacturers of electric car lighting equipment of the type in use today have little to fear from the extension of electric traction. Whatever may be the motive power used, car lighting will continue to be effected through an entirely separate and independent equipment.

## ASSOCIATION NEWS.

**This space in the paper is regularly devoted to news of the association. Through it the officers hope to keep in touch with the great and rapidly growing body of members scattered throughout the United States.**

**It will be open to communications pertinent to association matters. Any member who has anything to say to the other members is invited to make use of this column for that purpose. Such communications should be addressed to the secretary of the association.**

### NEW MEMBERS

The following new members to the Association were approved at the last meeting of the Executive Committee:

Robt.W.Brodmann, 12 N.LincolnAv,RockawayPr.N.Y.
E. L. Collins, 640 E. 71st. St., Chicago, Ill.
Claud E. Combs, 527 Englewood Ave., Chicago, Ill.
A. B. Cross, 701 S. Dearborn St., Chicago, Ill.
Thomas Ellwood, 1810 Michigan Ave., Chicago, Ill.
O. B. Duncan, c/o J. Lang Electric Co., Chicago, Ill.
B. H. Ehringer, 527 Englewood Ave., Chicago, Ill.
O. B. Funnie, 9th & Hennepin Av., Minneapolis,Minn.
Chas. Gelan, 1319 Lami St., St. Louis, Mo.
E. W. Gerdes, 4341 Prairie Ave., Chicago, Ill.
Frederick M. Holbrook, Glencoe, Ill.
Frank W. Jewett, 6400 Plymouth Ave., St. Louis, Mo.
Chas. E. Kacin, 1706 N. Washtenaw Ave, Chicago, Ill.
M. H. Johnson, Beech Grove, Indiana.
G. A. Murphy, 115 Front St., Kensington, Ill.
J. C. McGinnes, 1813 W. 47th St., Chicago, Ill.
R. J. O'Leary, 319 E. 41st St., Chicago, Ill.
H. F. Pfeffer, 2701 Sublette Ave., St. Louis, Mo.
Dalton Risley, 1011 Bowen Ave., Chicago, Ill.
John E. Snyder, 3336 Webster Ave., Pittsburg, Pa.
Geo. H. Stickney, 115 Park Ave., Schenectady, N. Y.
J. D. Sutfin, 3636 So. Wood St., Chicago, Ill.
Arthur J. Sweet, 173 W. Church St., Newark, Ohio.
Frank C. Watson, 1405 7th Ave., Huntington, W. Va.
Francis J. White, c/o Okonite Co., New York City.
G. S. Wood, 206 Gt. Northern Bldg,, Chicago, Ill.
Daniel Woodhead, 5323 Jefferson Ave., Chicago, Ill.

### CAR LIGHTING CLUB.

The April meeting of the Car Lighting Club was held at the Chicago Press Club on the evening of April 19. The subject for the evening was the "Cost of Car Lighting and How it Should be Figured." Mr. D. J. Cartwright, of the Lehigh Valley Railroad, was the principal speaker. His address appears below.

A very lively discussion followed Mr. Cartwright's paper. F. E. Hutchinson (Rock Island), described the method of accounting in use in his office and stated that with some slight alterations, this form was adopted for use on Harriman and connecting lines at the recent meeting of the electricians of these lines in Salt Lake City. The report is based upon car miles and expenses are reported per thousand car miles. Interest and depreciation are left out of consideration. Mr. Hutchinson gave some of the figures secured on his road. He also gave some figures on belt life, saying that 507 belts gave an average life of 21,000 miles each. Of these belts 72 per cent were lost and 28 per cent worn out. The average mileage of the worn out belts was over 37,000 miles; that of the lost belts, 14,000 miles. This shows that only a small fraction of the service quality of car lighting belts is being realized in actual service.

At the close of a discussion which was joined in by E. W. Jansen, W. J. Bohan, B. F. Fisher, Jr., and A. J. Sweet, the following resolution was passed as expressing the sense of the meeting. It is understood that it shall be reported to the Committee on Accounts and Reports of the Association of Railway Electrical Engineers.

RESOLVED: That the items of Interest and Depreciation be omitted from Car Lighting Accounts; that expenses arising from unavoidable accidents be carried on a separate account and not included in reports intended for comparison between roads.

# Car Lighting Cost Accounting

D. J. CARTRIGHT

I wish to confine my paper to the cost of axle lighted cars and let some other member give us figures on straight storage and head end systems.

The successful operation of car lighting is dependent on keeping proper account of our receipts and expenditures so arranged and divided that one can make an intelligent comparison between the cost of operation on our own cars as well as the cost of operation on other railroads. If the cost of any particular operation on your own road does not compare favorably with the cost of similar operation on other roads, we must look for the reason why and if possible, correct it.

To do this, we must get down to some uniform basis of keeping accounts, and adopt some unit of comparison, such as the cost per car per month. I do not believe it practical to figure costs on a mileage basis, as this entails an immense amount of unnecessary work. If any one wishes to further segregate the cost, it is his privilege, but in making this division, he should so arrange the subject matter that these items can be consolidated under one head. For example—under the heading of Generator, if one wishes to make sub-divisions, which will show the cost of repairs of armature, field coils, brush holders, etc., so much the better, but don't carry it too far.

For the past three years I have endeavored to keep an accurate account of the cost of operating axle lighted cars, equipped with three different systems, including all labor and material used in making repairs, improvements and betterments. The figures presented show the average cost per car per month, based on the average number of cars in service each month. If the cost was figured on the total number of cars equipped, the average cost of operation per car per month would be much less. (No interest or depreciation is allowed.)

COST OF OPERATION PER CAR PER MONTH.

| | |
|---|---|
| Lamps (1,008) | 3.22 |
| Fuses | .14 |
| Belts and clamps | 1.63 |
| Generator including suspension | 3.53 |
| Regulator including resistances | .44 |

| | |
|---|---|
| Storage battery (608) cells | 1.72 |
| Miscellaneous | .30 |
| | 10.98 |
| Labor | 10.38 |
| Total | 21.36 |

The average cost of lamps for 21 months on an average of 21 cars per month, including the first cost of 872—15 watt 32 v. Tungsten lamps and renewals on 542 8 candlepower carbon lamps was $3.22 per car per month, as stated above. The average cost of renewals for four winter months, on a total installation of 1,414 carbon lamps, was $2.70 per car month. The average cost of renewals for 4 winter months on a total of 1,414 —15 watt Tungsten lamps was 3.20 per car month.

The cost of $1.72 per car month for storage batteries includes the cost of all material necessary in making repairs on 608 cells of battery, including electrolyte. No renewals of Positive or Negative plates were necessary in that time.

In addition to the above amount, if it is desired to include the cost of haulage, we will assume that the equipment weighs two tons and that the car averages 10,000 miles per month, at .000257c per ton mile, which would make a grand total of $33.41 per car month.

This average cost seems large, but it is due to the fact that 14 of the 24 cars have a double equipment, of 32 cells of storage battery, and includes only 7 coaches, each with a single equipment of 16 cells, the cost of operating a coach being less than ½ the cost of operating a dining car, or two-thirds the average cost of all 24 cars.

If it is desired to include the cost of haulage, I believe the only items to be included should be coal, water and lubrication. For your information I obtained the total cost of coal, water and lubrication furnished to engines for an average month. Dividing this total cost by the total ton miles made by the train, it gave as a result a cost of .000257c per ton mile.

In the following table the cost of general supervision is not included as this item would vary with the number of cars in service.

I have given this subject considerable thought and submit the following as a method of keeping the cost of electric car lighting. The cost of electric lighting of cars should be divided into four parts:

First. Original installation, improvements and betterments.

Second. Wrecks.

Third. Maintenance of equipment (repairs).

Fourth. Transportation (operation).

COST OF OPERATION FOR DIFFERENT CLASSES OF CARS PER MONTH.

| Class of car— | Private | Coach | Chair | Dining | Library | Total | Average |
|---|---|---|---|---|---|---|---|
| No. cars | 3 | 7 | 2 | 9 | 3 | 24 | |
| No. lamps, average | 84 | .47 | 61 | 64 | 45 | 1414 | |
| No. cells, storage battery | 32 | 16 | 32 | 32 | 16 | 1008 | |
| Average cost per car— | | | | | | | |
| Lamps | 3.26 | 2.48 | 3.61 | 4.35 | 2.42 | | $ 3.22 |
| Material | 6.11 | 3.31 | 8.29 | 12.58 | 8.51 | | 7.96 |
| Total material | 9.37 | 5.79 | 11.90 | 16.93 | 10.93 | | 11.18 |
| Labor | 6.74 | 8.42 | 10.95 | 15.58 | 10.21 | | 10.38 |
| Total | 16.11 | 14.21 | 22.85 | 32.51 | 21.14 | | 21.56 |
| Interest, 5 per cent | 6.67 | 5.00 | 6.66 | 6.67 | 5.00 | | 5.90 |
| Depreciation, 5 per cent | 6.67 | 5.00 | 6.67 | 6.67 | 5.00 | | 5.90 |
| Grand total | 29.45 | 24.21 | 36.18 | 45.85 | 31.14 | | $33.36 |

## The Method of Keeping Accounts and How Distributed.

### First Account, Original Installation, Etc.

**Debits.**

(a) Cost of original installation.
(b) Cost of improvements and betterments.
(c) Interest.
(d) Depreciation.

**Credits.**

(a) For all electric material removed from car which was a part of the original installation.

(b) For all electric material removed from car which was installed as an improvement or betterment.

This account should not be credited with any material removed on account of wrecks.

### Second Account—Wrecks.

(a) Cost of material and labor, making electrical repairs due to wrecks on our own road.

(b) Cost of material and labor making electrical repairs due to wrecks on foreign roads.

To be credited for all electric material removed from car, due to wrecks, or money received from foreign roads, or department on account of wreck.

### Third Account—Maintenance.

(a) Cost of material and labor making electrical repairs to equipment due to operation of own or foreign cars.

(b) One half the cost of general supervision.

(a) To be credited for old electric material removed on account of repairs or renewals, not caused by wreck.

(b) One-half the moneys received from foreign roads on account of electric lighting cars.

(c) All moneys received on account of repairs made by the M. of E. on foreign cars to electrical equipment.

### Fourth Account—Transportation.

(a) Cost of supplies consumed, such as lamps, waste, oil, fuses, recharging storage batteries, etc.

(b) One-half the cost of general supervision.

(a) One half the moneys received from foreign roads on account of electric lighting cars.

(b) Scrap value of all material charged to transportation when same has been removed from car.

## HARRIMAN LINES ELECTRICIANS' CONFERENCE.

The men in charge of train lighting on Harriman and connecting lines met in Salt Lake City on April 10, 11, 12 and 13. The meetings were held in the Oregon Short Line station. All train lighting subjects from batteries to turbines came in for discussion and exchange of ideas. Several recommendations for standard specifications were made. Nearly all the recommendations made at the meeting something over a year ago have now been adopted by the various roads.

A. J. Farrelly, electrical engineer Chicago & North-Western Railroad, was elected permanent chairman and will call the next meeting in Denver in May, 1912.

Fig. 1.—Interior of Steel Coach, C. G. W. Railroad.

The representatives present were:

Chicago & North-Western—A. J. Farrelly.

Illinois Central—A. L. Chapin.

Oregon Short Line—H. R. Bucks, H. A. Gillies, H. B. Glaze, E. W. Newcomb, J. R. Wills, J. S. Woffington.

O.-W. R. & N.—O. F. Wiley.

Rock Island—F. E. Hutchinson.

S. P., L. A. & S. L.—Geo. W. Murrey.

Southern Pacific—E. M. Cutting, J. J. Hack, D. L. Brainard, S. T. Sikes.

Union Pacific—Geo. Griswold.

## THE GREAT WESTERN'S NEW STEEL TRAIN.

The Chicago Great Western Railway has recently put in service between Chicago and the Twin Cities a new all steel train which compares very favorably with any on other roads. The train makes the night run in both directions, leaving Chicago at 6:30 p. m. and reaching Minneapolis at 8:30 the following morning. The train leaving Chicago is composed of a baggage car, smoker, coach, club car, diner, sleeper and compartment sleeper with observation parlor.

The train is electric lighted throughout by the axle system. No train lines are carried, as the Great Western does not interchange cars with roads using the head-end system of lighting. A feature which adds greatly to the lighting is the light colored ceilings which are used in all the cars. Shades are used throughout, there being no bare lamps except in the vestibules.

The coaches are lighted by single bracket lamps mounted on the deck sash. Twelve of these lamps are placed on each side of the car, producing an adequate and evenly distributed illumination over all the seats. The interior of the coach is shown in Figure 1.

The club car is built in two compartments, one reserved for ladies traveling alone and fitted like the ordinary chair car, and the other for reading and smoking. This compartment, which is shown in Figure 2, is lighted by bracket fixtures, some single and some two-light, and by 6 box fixtures in the ceiling of the car, each containing a 24-watt tungsten lamp under a reflector. The car is finished in solid English oak with dove-gray ceiling of asbestos composition. The upholstering is in red Spanish leather. A total of 45 tungsten lamps are used in the lighting of this car. The axle equipment is a Safety Type D.

The dining car ceiling is green with white decorations. Six ceiling fixtures of four lamps each and a stand lamp on each table furnish the illumination. The dining compartment is ventilated by two Jandus gyrofans in the ceiling. The car contains a total of 65 15-watt tungsten lamps. A double Type A Consolidated equipment is used.

The standard sleeper is lighted by eight 4-lamp ceiling fixtures with two lights in every berth, and contains a total of 134 lamps. Four Diehl fans are used for ventilation.

Each of the nine compartments in the compartment sleeper is lighted by a four-light ceiling fixture in addition to the usual berth lamps. Each compartment has a fan and there are two additional in the observation parlor, making a total of 11 fans on this car. The finishings are in mahogany and Circassian walnut, with a ceiling light tan in color. The car contains a total of 117 lamps. The axle equipment is a Safety Type A.

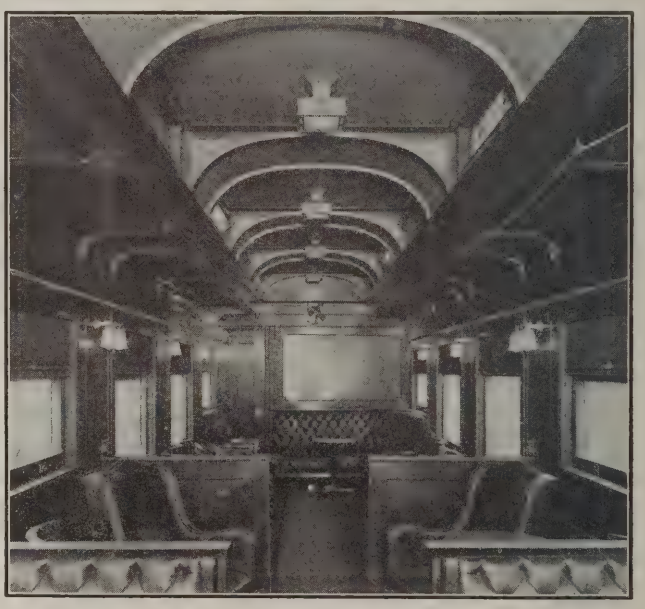


Fig. 2.—Interior of Club Car, C. G. W. Railroad.

This train embodies the latest ideas in scientific construction and artistic illumination. The car walls are of steel with a hair felt lining and an outer separate steel siding. Safety and Consolidated axle generators and Willard batteries are used.

## AN ADJUSTABLE HEADLIGHT REFLECTOR.

When Messrs. Harding and Topping investigated the electric headlight at Purdue University they reported that the two principal objections to it were: (1) that it caused reflections from the signal rondels, which gave what are termed "phantom" signals, thus

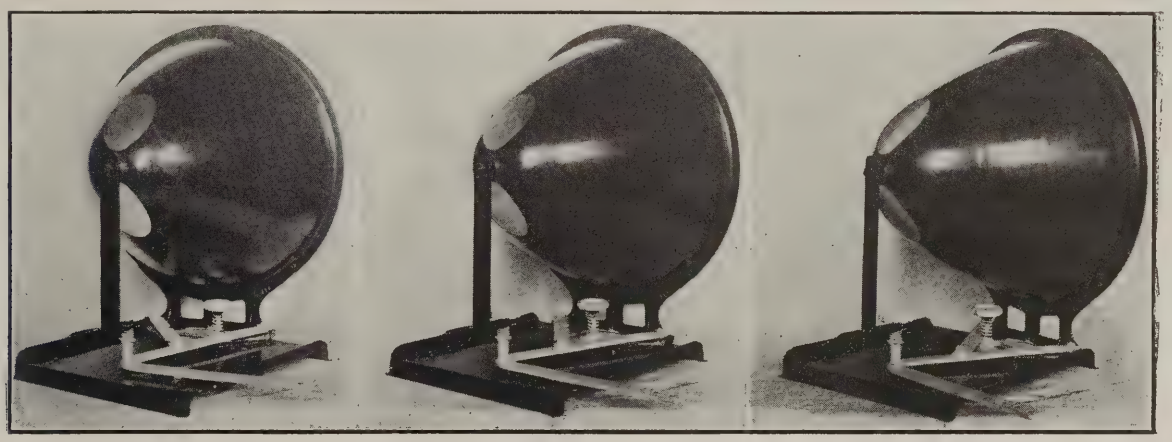
obscuring the true nature of the signals displayed, and (2) that the glare of an approaching headlight on a parallel track obscured signals beyond the approaching headlight and the classification signals on the locomotive as well.

To remove these two objections, and to gain the additional advantage of being able to throw light along curves, is the function of the adjustable reflector recently patented by J. R. Pratt.

In his work as electrician on the M. K. & T. at Denison, Tex., Mr. Pratt had charge of the maintenance work on electric headlights. One difficulty found with them was that of adjusting the casing on the locomotive so as to shoot a clear beam of light down the center of the track. To make this adjustment more easily he devised a separate base for mounting the reflector. By means of this base the adjustment could be made by simply moving the reflector without moving the whole headlight.

From this it was but a step to an adjustable reflector which could be controlled from the cab, thus virtually transforming the headlight into a search light. The lever arm seen in the cuts was added, and to this was attached a rod leading to the cab. Thus the engineer is able to swing his headlight at will, and can sweep over a curve long before he reaches it. This is impossible with any automatic arrangement which would have to depend either upon the swing of the trucks or the superelevation of the outside rail. When approaching a signal or another locomotive, the light can be momentarily thrown to one side of the track, thus avoiding any danger of false signals.

The reflector revolves about the light source, which, in the case of an electric arc, is practically a point. It is held in any position by the spring which presses the extra base against the main base.



Left Deflection. Centered. Right Deflection.

Fig. 1.—Showing Deflection of Pratt Adjustable Reflector.

Figure 1 illustrates the movement of the reflector, which is shown in three positions. Figure 2 shows the reflector in service, the box car in the center of the photograph being on the same track as the locomotive and the reflector swung to the right so as to cut across the curve. With the headlight set straight ahead, this car would not be visible from the locomotive at this point.

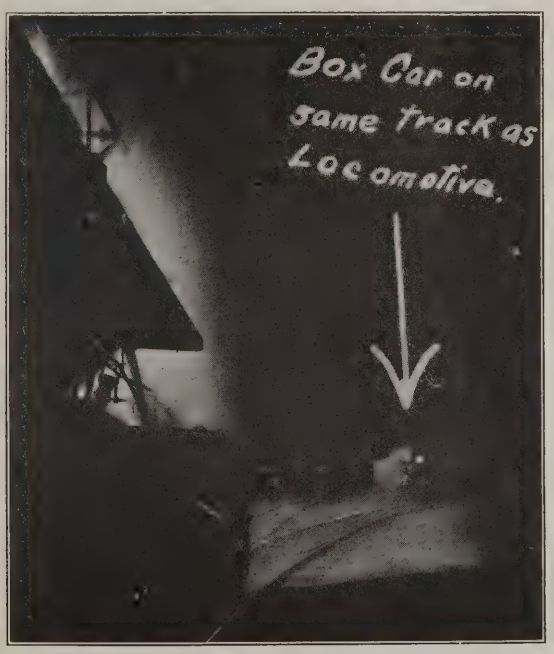



Fig. 2.—Reflector in Use on M. K. & T. Railroad.

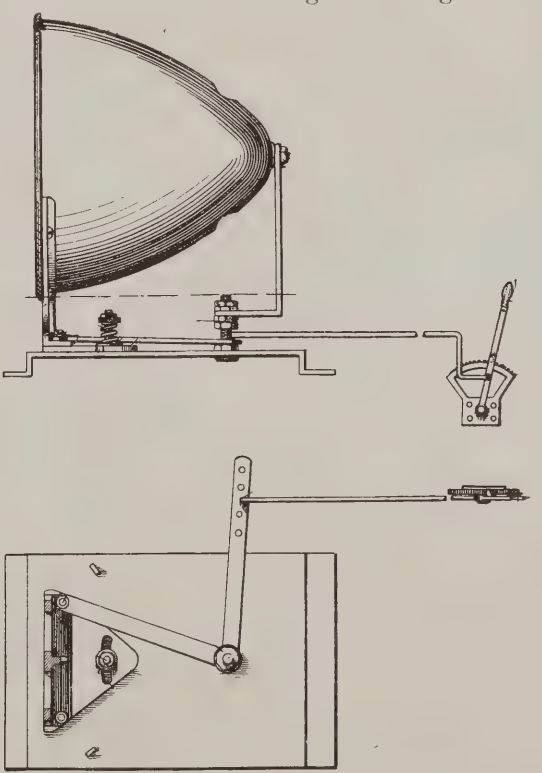


Fig. 3.—Plan and Elevation of Reflector.

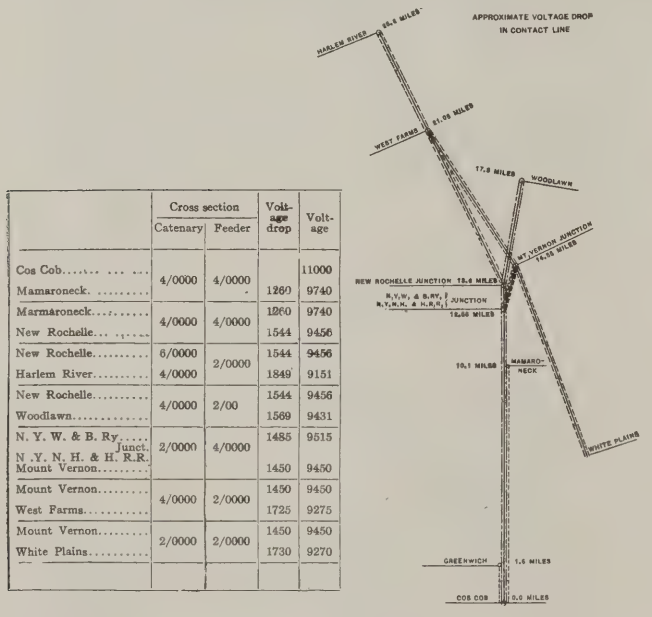
These reflectors are now in service on the Missouri, Kansas & Texas Railroad, and are being tried out by others. The additional cost is about 3 per cent of the total cost of an electric headlight equipment.

# Latest Data on New Haven Electrical Operation

Trunk Line Electrification was the subject of a very elaborate paper presented by W. S. Murray, electrical engineer N. Y., N. H. & H. R. R., before the American Institute of Electrical Engineers at Toronto, Ont., April 7.

Mr. Murray said in effect, that the problem of making electrification pay, settles down to how much it costs to produce the necessary tractive effort in (1) passenger express locomotives, (2) passenger local locomotives, (3) freight road engines, (4) freight switch engines.

The tests on locomotives reported by Messrs. Stillwell and Putnam presented before the Institute in 1907 showed the following coal consumption per ton




| | Cross section | | Voltage drop | Voltage |
|---|---|---|---|---|
| | Catenary | Feeder | | |
| Cos Cob | 4/0000 | 4/0000 | | 11000 |
| Mamaroneck | | | 1260 | 9740 |
| Marmaroneck | 4/0000 | 4/0000 | 1260 | 9740 |
| New Rochelle | | | 1544 | 9456 |
| New Rochelle | 6/0000 | 2/0000 | 1544 | 9456 |
| Harlem River | 4/0000 | | 1849 | 9151 |
| New Rochelle | 4/0000 | 2/00 | 1544 | 9456 |
| Woodlawn | | | 1569 | 9431 |
| N. Y. W. & B. Ry. Junct. | 2/0000 | 4/0000 | 1485 | 9515 |
| N. Y. N. H. & H. R.R. Mount Vernon | | | 1450 | 9450 |
| Mount Vernon | 4/0000 | 2/0000 | 1450 | 9450 |
| West Farms | | | 1725 | 9275 |
| Mount Vernon | 2/0000 | 2/0000 | 1450 | 9450 |
| White Plains | | | 1730 | 9270 |

Diagram of N. Y., N. H. & H. Electrified Zone, Showing Drop in Voltage.

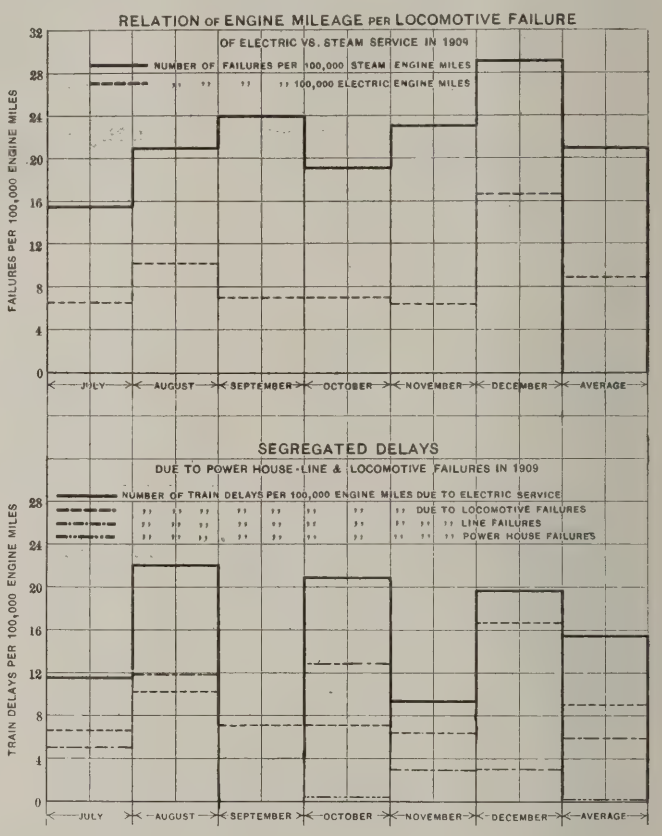
mile for steam locomotives in different classes of service: freight 0.169 lbs., express passenger, 0.194 lbs., local passenger, 0.335 lbs.

From these figures it was calculated that the electric passenger locomotives on the New Haven should produce 1,000 horsepower and this sized unit has proved satisfactory in actual service.

Based upon similar tests, the freight locomotives were designed with a capacity of 1,400 h.p. In a recent test one of these locomotives hauled a total train weight of 1,438 tons at an average speed of 36½ m.p.h. and developed 1,650 h.p., the energy consumption being 25.9 watt-hours per ton mile. In local passenger service the same locomotive consumed 58.8 watt-hours per ton mile on hauling a 500 ton train.

A test of a steam switch engine showed an average horsepower with the throttle open of 313, but as the throttle was open but 37 per cent of the time, the average power developed per hour was only 115 h.p. The type of electric switch locomotive which is soon to be tried out will have four motors with an hourly rating of 150 h.p. each, giving the locomotive a total capacity of 600 h.p.

Actual records of electrical operation on the New


RELATION OF ENGINE MILEAGE PER LOCOMOTIVE FAILURE
OF ELECTRIC VS. STEAM SERVICE IN 1909
NUMBER OF FAILURES PER 100,000 STEAM ENGINE MILES
" " " " 100,000 ELECTRIC ENGINE MILES
FAILURES PER 100,000 ENGINE MILES
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
AVERAGE
SEGREGATED DELAYS
DUE TO POWER HOUSE-LINE & LOCOMOTIVE FAILURES IN 1909
NUMBER OF TRAIN DELAYS PER 100,000 ENGINE MILES DUE TO ELECTRIC SERVICE
" " " " " " " " DUE TO LOCOMOTIVE FAILURES
" " " " " " " " LINE FAILURES
" " " " " " " " POWER HOUSE FAILURES
TRAIN DELAYS PER 100,000 ENGINE MILES

Failures of Electric and Steam Locomotives.

Haven show that the average delay per train was reduced from 27 seconds in 1908 to 5.25 in 1909. Between Nov. 2 and Nov. 23, 1909, 66,000 electric locomotive miles were run with a total of 3 minutes delay.

The accompanying diagrams show a decided superiority of electric operation over steam in point of reliability. From the lower diagram it will be seen that a large number of electrical failures are due to line failures, a number of which can be traced to the bad effects of steam locomotive stack discharges on the overhead trolley wire.

Mr. Murray then described in considerable detail the power house and distribution system used on the New Haven. The accompanying illustration shows the diagram of the system with the size of wire used and the voltage drop. The maximum load experienced on this system was on the day of the annual Yale-Harvard foot ball game at New Haven, Nov.

19, 1910. The maximum line drop for this day at the end of the line was 14 per cent.

Mr. Murray emphasized the necessity for perfect insulation, saying that it was poor economy to save money on first cost and run the risk of severe loss due to breakdowns. He also called attention to the advantages of a steel contact wire.

A description of the changes made on the electric locomotives in the past two years is given. The use of the straight alternating current equipment makes it possible on some of the new locomotives to reduce the weight of their electrical equipment from 55,000 to 47,000 lbs.

In regard to costs, Mr. Murray says: "In this department I am quite in agreement with the previously scorned adage: Every situation is a study in itself. For, while in my opinion no trunk line electrification can be better served than by the use of single-phase current, it must be conceded that electrification costs must vary with the greatly fluctuating condition of volume and density of traffic involved."

The following well-known figures on cost are given: Power houses, $90.00 to $110.00 per kw. Line construction for 1, 2, 4 and 6 tracks, $4,000.00 to $7,000.00; $8,000.00 to $15,000.00; $25,000.00 to $40,000.00; and $40,000.00 to $60,000.00 a mile. Yard construction, $1,500.00 to $3,000.00 a mile. Locomotives from $25,000.00 to $40,000.00 a unit.

The question of choice of systems, Mr. Murray made his opinion very clear, saying that he was strongly in favor of the universal use of the single-phase system with 11,000 volts, 25 cycle current.

## Selection of Detroit River Tunnel Electrical Equipment

Mr. W. J. Wilgus, consulting engineer, and formerly vice-president of the New York Central, recently presented a very interesting paper before the English Institution of Civil Engineers on "The Detroit River Tunnel." He described in great detail the history of the river crossing projects, the tunnel design, the construction, and the costs.

Of particular interest to electrical engineers is the part of the paper which deals with the electrical equipment. It brings out, clearer than anything we have thus far seen, the relative advantages of the three different electric systems in their application to an actual case.

Mr. Wilgus first enumerates the conditions which had to be met. Then he explains as regards choice of system: "The fiercely asserted rival claims made by the advocates of various methods of electrification rendered imperative the adoption of a means of reducing arguments to some measurable basis that would be equally fair to all, and afford the advisory board justification for selecting an electric propulsion system that would combine safety and reliability with economy."

In compliance with this policy, specifications were prepared setting forth the physical conditions as to alignment and gradients, the speed, frequency and weight of both classes of trains, the lighting and pumping, and all other information needed to understand the results desired by the tunnel company.

Each bidder was to submit a proposition for a definite equipment to meet these conditions. The greatest possible freedom was left him in the choice of details. The specifications went so far as to say that, if he deemed any of their requirements prohibitive to the free exercise of his skill, he could submit his own alternative suggestions. Thus the various electric systems were placed on a strictly fair and at the same time on a directly comparable basis.

As the annual cost of operation should have equal consideration with first cost in determining which system was to be adopted, bidders were required to estimate the annual costs of the system upon which they bid, including in their figures fixed charges as well as operating expenses, and to enter into a formal guarantee protecting the tunnel company against higher costs than those estimated.

Proposals were received from three companies, for direct current, three-phase and single-phase equipment respectively.

In comparing the three bids with one another the paper does not give the bid prices, but uses percentages instead. It is pretty well known, however, that the electrical equipment actually installed cost in the neighborhood of $1,000,000 and we thus get a very fair measure of the real dollars and cents advantages of the three systems represented.

COMPARISON OF BIDS FOR DETROIT RIVER TUNNEL ELECTRIFICATION.

| | Locomotives for the Specified Service. | | | Comparison of Costs for Entire Equipment. | |
|---|---|---|---|---|---|
| System— | Weight of Each. | Number Required. | Aggregate Weight. | First Cost. | Annual Cost (incl. Fixed Charges, Operation and Maintenance). |
| Direct Current | 89¼ tons | 8 | 714 tons | 100 per cent | 100 per cent |
| Three Phase | 72¼ tons | 8 | 578 tons | 112 per cent | 104 per cent |
| Single Phase | 53½ tons | 16 | 856 tons | 132 per cent | 120 per cent |

Mr. Wilgus' tabulation of the bids is shown in the accompanying table:

The difference between the direct current system and the single-phase system is marked, being 32 per cent against single-phase in first cost and 20 per cent. in annual operating cost. The adoption of the single-phase system would have imposed upon the Tunnel Company an added burden of nearly $40,000 per annum. The difference between the direct current system and the three-phase system is less prominent, being 12 per cent, against three-phase in first cost and only 4 per cent in annual operating cost. The limited stretch thus far electrified does not fully bring out all the advantages of the alternating current systems.

The weight characteristics of the three types of locomotives are brought out very clearly by the three bids. Three-phase locomotives are the lightest; direct current locomotives come next, and single-phase locomotives are the heaviest of the three—the relation being as 578: 714: 856.

This is a very important factor in heavy service.

# Electrification of Trunk Lines from the Operating Mans Point of View

In the current issue of the *Engineering Magazine,* Mr. A. D. Williams enumerates some disadvantages of electrification which he claims are of sufficient magnitude to require a reassuring answer from the electrical engineer before the railroad operating man can consider the general problem of trunk line electrification.

He enumerates the following:

1. In case of a blockade of any kind on an electrified section of a railroad the emergency conditions cannot be successfully met, i. e., trains cannot be detoured under their own motive power.

2. There is no standard system of electrification. A system installed today may have to be scrapped in the future and replaced by another system which, in the meantime, may have turned out to be the "right one."

3. An extremely heavy traffic of merely temporary character cannot be taken care of by an electric plant which was put in for normal traffic.

4. The question "Will it pay?"

It is very interesting indeed to have the doubts of the operating man thus voiced in concrete form, but we do not agree with Mr. Williams on the importance of his objections, certainly not as regards the first three. We do not think that any reasonable railroad man would refuse to consider electrification on account of them. Let us look at them one at a time.

In regard to the first point:

No electrical engineer at the present stage of the game advocates the universal electrification of trunk lines. The lines that are worthy of electrification today are those with the heaviest traffic, the main lines. They have permanent and substantial roadbeds. The chance of a total blockade due to washouts, collapsed bridges, etc., is extremely small. Wrecks are rare, as most or all of these lines are equipped with automatic block signals, or would be so equipped along with electrification. Even an occasional wreck, in these days of advanced wrecking machinery, would mean the closing of the line for a few hours at the most. The detouring of the few trains, under motive power other than their own, which this would involve, is not a problem of sufficient magnitude to make operating managers look upon electrification with disfavor.

In reference to the second objection—lack of standardization:

The steam railroad man can be met with assurance on this point. There will never be any standard system of electric equipment, any more than there is today a standard type of steam locomotive. The advantages and limitations of each electric system are quite well known at this time and the lines between the classes of service to which each applies are pretty sharply drawn. Pick out the system that is suited to your traffic today and it will always be satisfactory, provided, of course, that the nature of the traffic is not revolutionized. To be sure, there are some things which should be standardized, and which are practically standardized already, namely, location of third rail, height of trolley wire, etc.

Regarding the third point:

Electricity *can* and *does* meet extraordinary fluctuations of traffic. It is accomplished by the simple means of a portable sub-station or transformer car. This can be temporarily tapped on to the main transmission line anywhere in the vicinity of the heavy traffic and it will remain there as long as needed to supply the extraordinary demand for local current.

The fourth point is indeed one of great importance and one which has to be studied carefully. It is strictly analogous to the question, "Will double-tracking pay?" with which most railroad managers are already familiar. No doubt there are plenty of cases where electrification will pay, and pay handsomely. Doubtless there are others where it won't. In considering the question of cost, the increased capacity of the line after electrification must be given due weight. In special cases, incidental advantages such as smoke prevention, etc., will have a deciding influence. However, the question is one which requires a very careful and detailed investigation to determine it accurately. It cannot be decided in an offhand manner any more than the question of double-tracking can be thus settled. Treated with care by men well acquainted with the various factors involved, it admits of a very accurate and satisfactory solution.

The trouble with railroad electrification as a whole has been the fact that it has thus far been handled rather too much by the manufacturers of electrical machinery. They, very naturally, are engrossed in the special advantages of the equipment which their factories produce, and they can hardly be blamed if, in their desire to sell their goods, they have sometimes lost sight of some of the more general aspects of electrification.

We would hardly go to a rail manufacturer for advice on the question of double-tracking a certain portion of our road, nor would we hire a locomotive manufacturer to carry through a certain piece of grade reduction. Both the rail manufacturer and the locomotive builder might be called upon to give their opinion on certain features of the problem so that we might be thoroughly acquainted with the operating characteristics of their products, but the work of designing the improvement and of carrying it through would be done by the company's own engineers with or without the advice of outside experts.

Exactly the same method should be used in cases of electrification. It is perfectly correct to call upon the manufacturers of electrical equipment for a statement of what their apparatus will do under certain specified conditions. But the working out of the cost of the improvement, the establishing of the probable increase in return which will follow, and the weighing of the advisability of incurring the cost with a view to obtaining the increase in return, these as well as the final laying out of the details and the picking out of the system best adapted to the particular needs, are things that had best be done by the railroad company's own engineers with or without the assistance of outside men especially versed in the intricacies of electric operation.

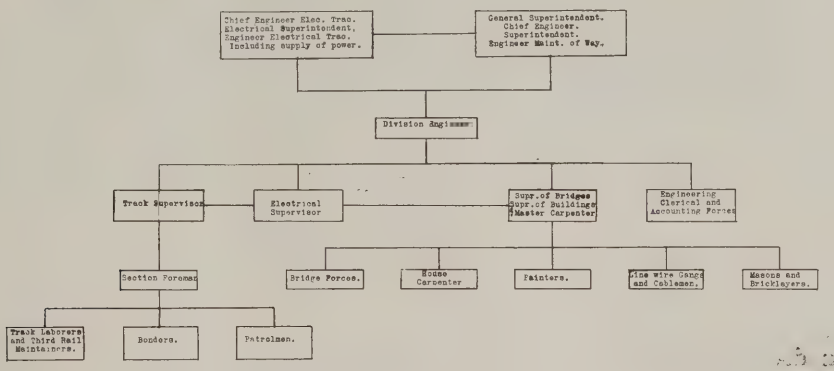
The sooner railroad managers in general adopt this procedure, the sooner will they come to realize that almost every large railroad system of today possesses one or more divisions where electrification is truly applicable and where the use of electricity as motive power will work wonders in the way of increased net returns.

## MR. L. C. FRITCH ON ELECTRIFICATION.

In opening the twelfth annual convention of the American Railway Engineering and Maintenance of Way Association, Mr. L. C. Fritch, president of the association and chief engineer of the Chicago Great Western Railway, said in part:

"The progress of railway engineering during the past year is perhaps best exemplified in the opening for service of the New York terminals of the Pennsylvania, including the tunnels under the Hudson and East rivers. This great achievement, made possible only by the ability, foresight and courage of that splendid type of man and engineer, Alexander J. Cassatt, is a fitting and lasting tribute to his genius and memory. It marks an epoch in railway progress, being the first large trunk line railway terminal complete in its operation with electric traction. This installation awakens us to the sense of a new responsibility that is placed upon us as engineers, and that is, that we should prepare ourselves for the new problems that it will be our duty to solve. It will devolve upon the engineers of our railways to determine to what extent the use of this new power is justifiable in heavy trunk line service. The question of electrification of trunk lines and its application to terminals in large cities has assumed the proportions of a public question in the cities of Boston, Philadelphia, Baltimore, Washington, St. Louis, Chicago, and its extension in New York City to all classes of service is being considered.

"It is a problem of great magnitude and involves not only technical skill, but judgment of the highest order, and its solution must, in the final analysis, be made by railway men, familiar with the intricacies of railway operation and its needs. My advice, therefore, would be that railway engineers prepare for this economic change that has already begun, in order that the problems that demand solution may be solved on a sound basis, and that costly mistakes, which ignorance would otherwise impose, may be avoided."




Maintenance Organization for Electrified Trunk Lines.

The report on Transmission Lines and Crossings relates chiefly to lines carrying electricity at high voltage across a railroad right of way. The necessary clearances, construction, insulation and precautions to be observed that accidents may be avoided are outlined in the report.

The most interesting report is that on Maintenance Organization. The organization recommended by the committee is shown in the accompanying diagram. The result of this organization is to bring the maintenance of the various parts of the electrical equipment under the charge of the regular maintenance of way departments with which they are most closely allied—track maintenance under section foremen, line wire maintenance under the superintendent of bridges and buildings, etc. The chief engineer of electric traction and the electrical engineer rank with the general superintendent and the chief engineer, while the electrical supervisor advises with both the bridge and track departments.

## MAINTENANCE OF WAY ASSOCIATION REPORTS ON ELECTRICITY.

Reports were made on the following subjects: (1) Clearances. (2) Transmission Lines and Crossings. (3) Insulation. (4) Maintenance Organization. (5) Electrolysis. (6) Relation to Track Structures.

The subject of clearances refers to the location of the third rail. In order that this may not interfere with any rolling stock, it is desirable that a standard position should be adopted. This standard should also be recognized by the car builders so that new rolling stock equipment will not encroach on the space allowed for the third rail.

## CHICAGO TERMINAL ELECTRIFICATION STUDY.

The Chicago Association of Commerce has arranged for a commission to study the problem of the electrification of the railway terminals in Chicago. The commission is very representative and should be able to hand down a definite and authoritative opinion on the matter. The expenses of the investigation, which will include the salaries of a chief engineer and a corps of assistants, will be borne by the railroads. The personel of this commission is as follows:

W. A. Gardner, president Chicago & Northwestern.

H. G. Hetzler, president Chicago & Western Indiana.

Darius Miller, president Chicago, Burlington & Quincy.

C. E. Schaaf, vice-president New York Central Lines.

Paul P. Bird, city smoke inspector of Chicago.

Dr. W. A. Evans, health commissioner of Chicago.

W. F. M. Goss, dean of engineering, University of Illinois.

E. R. Graham, D. H. Burnham & Company.

Milton J. Foreman, chairman Transportation Committee, city council.

R. C. Hall, president Duck Brand Company.

H. B. Riley, president Chicago Title & Trust Company.

M. B. Starring, president Northwestern Elevated Company.

F. H. Rawson, president Union Trust Company.

Jesse Holdom, attorney.

J. W. Scott, Carson, Pirie, Scott & Company.

A sub-committee composed of Messrs. W. F. M. Goss, Dean of the College of Engineering at the University of Illinois; E. R. Graham, of D. H. Burnham & Co., and H. G. Hetzler, president of the Chicago & Western Indiana Railroad Company, was appointed to select a chief engineer and staff of assistants to work out the engineering problems involved.

At a meeting held at the Union League Club in Chicago on April 14 Mr. Horace G. Burt, formerly president of the Union Pacific, was appointed chief engineer and he will start on his work at once.

Mr. Burt has been in railway work since 1868 when he became a rodman on surveys on the St. Louis, Vandalia and Terre Haute. He graduated from the engineering department of the University of Michigan in 1872. Then he was successively civil engineer, division superintendent, chief engineer, general manager and vice-president of the Chicago & Northwestern, during a period of 25 years, and finally president of the Union Pacific for six years, immediately preceding Mr. Harriman.

The commission will establish permanent headquarters in the People's Gas Building and after May 1st will meet every second Friday afternoon. Reports of progress will be made from time to time.

# Railway Shop Series—I. —The Pullman Company

The principal shops of the Pullman Company are in Chicago along the line of the Illinois Central railroad, in the south side of the city. They cover an area half a mile wide by two and a half miles long, and are in three main divisions.

These shops were started before electricity was being practically applied. The machinery was driven by steam engines supplied from various boilers about the grounds. A Central Boiler Plant was built in 1906 to secure higher efficiency. This is located near the center of the passenger car shops and housed in a brick building 80 ft. x 131 ft. in size, with a 250 ft. brick stack.

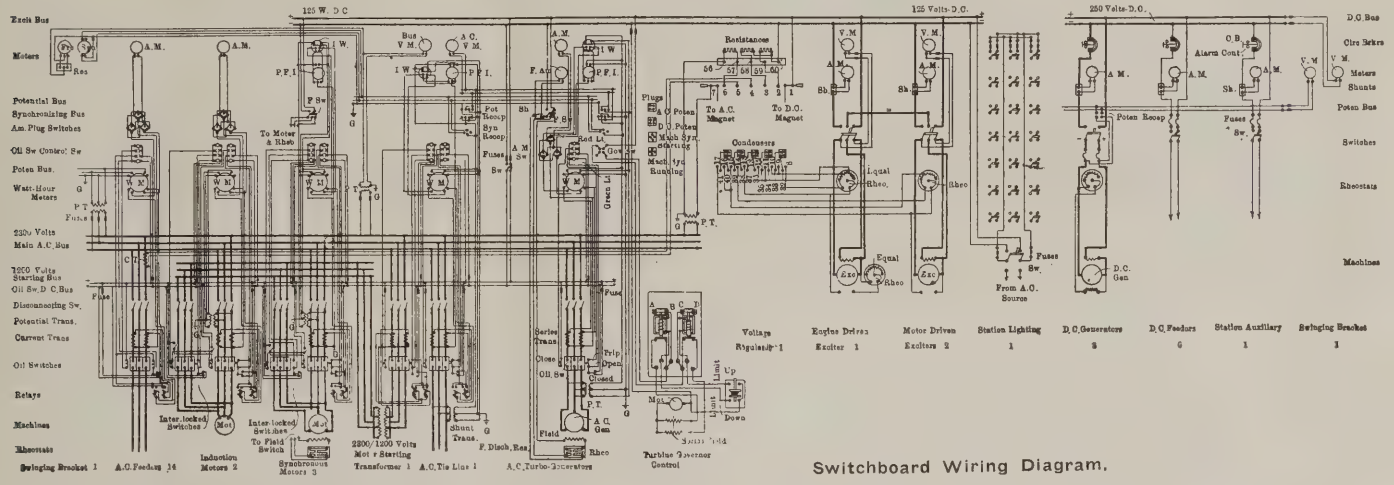
Interior of Central Power Plant—Pullman Shops.

### New Central Power Plant.

The new central power plant is about 200 feet from the steam plant and near the load center of the passenger car shops. It is of red brick, 65x180 feet inside, on a very heavy concrete foundation. The foundations for the turbo-generators and air compressors are also very heavy, with openings for piping, etc. A separate room is provided in the basement for the high tension apparatus. Fresh air, entering this room through a large duct passes up through the turbo-generators for ventilation, the rotors acting as fans to create a strong draft.

Conduits for all wires are built into the walls and floors. These lead from the generators and auxiliaries to the high tension room and switchboard. The conduits for small conductors are iron; for the large conductors, fibre. For convenience in changing con-

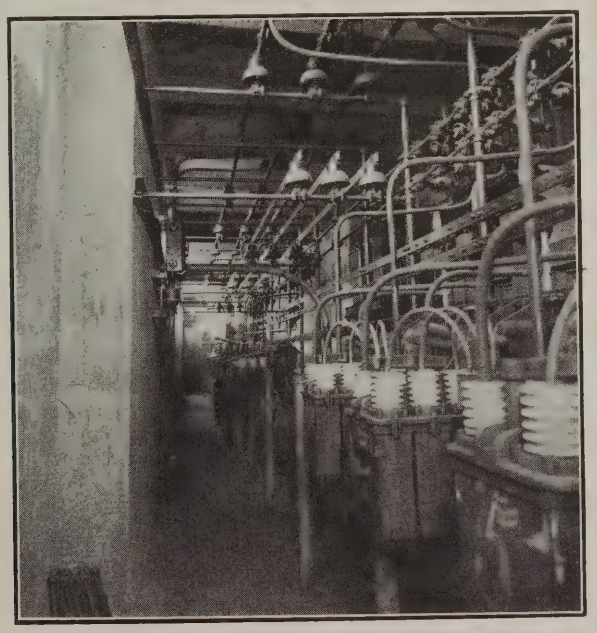
nections, all cables are carried into two pits in the floor of the high tension compartment. Outside the building there is a large vault which forms the starting point for the underground electrical distribution system. From this vault three sets of conduit, 16 ducts each, run to the other vaults about the plant. This vault is connected to the vault in the high tension room by two 24 duct Orangeburg fibre conduits. A tunnel 6 ft. high by 10 ft. wide carries the steam




Switchboard Wiring Diagram.

and water pipes between the boiler plant and the power plant and the steel passenger car shops.

Two 2,000 k. v. a. generators direct-connected to horizontal Parsons turbines are at present installed, with room for a third unit of the same size. These turbines take steam at 150 pounds pressure with a 28-inch vacuum. The governors may be adjusted for



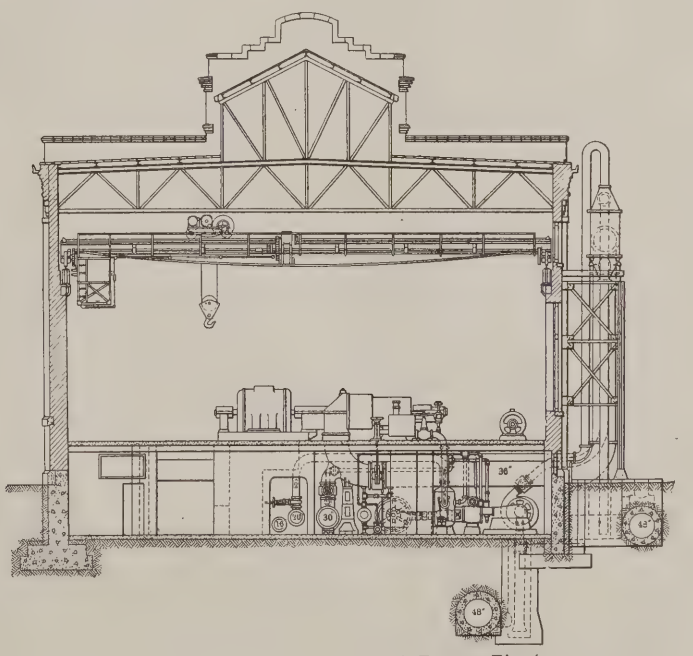
Controlling Apparatus in High Tension Compartment.

speed while running in order to divide the load or synchronize more readily. This is done electrically from the switchboard. The k. v. a. rating is at unity power factor. They deliver 3-phase 60-cycle current at 2,300 volts and are at present operating with a power-factor of 92 per cent. The main valves for the turbines are operated by 3 h.p motors on the 110 volt direct current circuit.

One of the two exciters at present installed is direct coupled to an "Ideal" horizontal engine. It is rated at 60 kw. at 125 volts, 275 r.p.m. The other is of the same capacity and is driven by a 90 h.p. 2,300 volt, 3-phase induction motor. Continuous current is obtained from a motor-generator set consisting of a 300 kw. 250 volt, 600 r.p.m. generator coupled to a 430 h.p. 2,200 volt synchronous motor. Provision was made for two other motor-generator sets of this size but fewer direct current motors are being used than were planned for. This motor operates at 97 per cent power factor and improves the power factor of the generators.

## Main Switchboard.

The switchboard is made of 2-in. white Italian marble mounted on iron pipes. The board is 7 ft. 6 in.



Cross Section of Central Power Plant.

high and in 38 panels. The direct current switches and instrument are grouped at the left end. At the extreme left are 2 direct current volt meters, one connected to the 250 volt busses, the other to the 250 volt generators, which are used to indicate the voltage before paralleling. Fourteen of the panels are used for d. c. circuits and 23 for the a. c. circuits. No high tension current comes to the board, all instruments being operated through transformers. The a. c.

switchboard carries a synchroscope and a frequency indicator.

The station is lighted by 3 500 watt Tungsten lamps, hung from the center of the ceiling above the cranes and equally spaced along its length. Between each of the windows is a steel bracket carrying 3 40 watt tungsten lamps. As the room is finished in white glazed tiling and white paint, excellent illumination is secured from a comparatively small number of lamps.

### High Tension Compartment.

In comparison with other recent instalations there is no high potential current in the Pullman shops. However the 2,300 volt controlling apparatus is concentrated in one room in the basement. No wires are carried outside of conduit except from the main busbars to the oil switch, and this is heavily insulated. The 2,300 volt busses are mounted on 13,000 volt porcelain insulators. The 1,200 volt bars are used only for starting the a. c. motors. These also are carried on 13,000 volt insulators. The 2,300 volt busses are spaced in 12-in. centers and laminated by using 2-in. x ¼-in. copper bars in multiple. The 1,200 volt busses are spaced 8-in. centers. Two manually operated sectionalized switches are placed in each of the 2,300 volt busses as indicated on the "System of Connection" herewith. A 40-kw. 2,200/1,200 volt transformer is used to energize the motor starting busses, and a 30-kw. 2,200/100 volt transformer for station lighting.

The framework used in this compartment for carrying the apparatus consists of heavy iron pipe set vertically, with horizontal steel strips. There are no crossed wires in the station, all paths being short and direct, which gives the impression of simplicity.

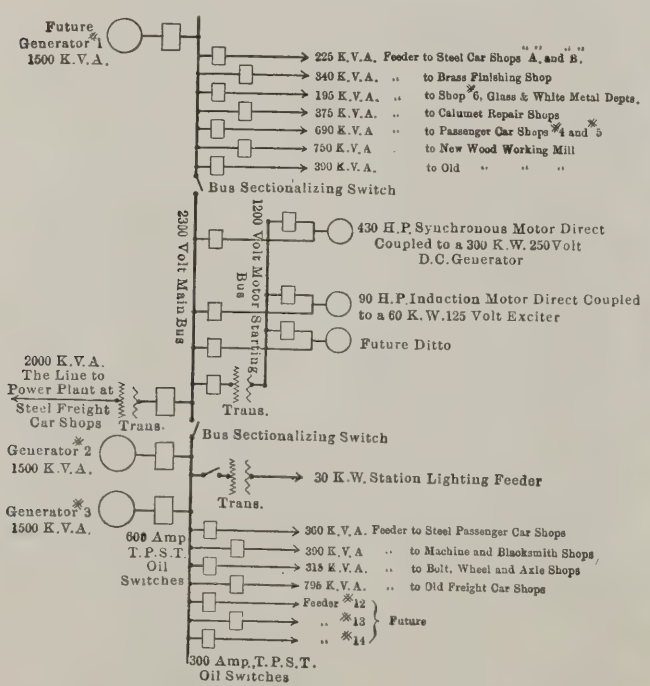
The oil switches are operated by direct current and are mounted on the rear of the framework 4 ft. from the floor. This makes them readily accessible for manual operation in case of necessity.

### Freight Car Shop Power Plant.

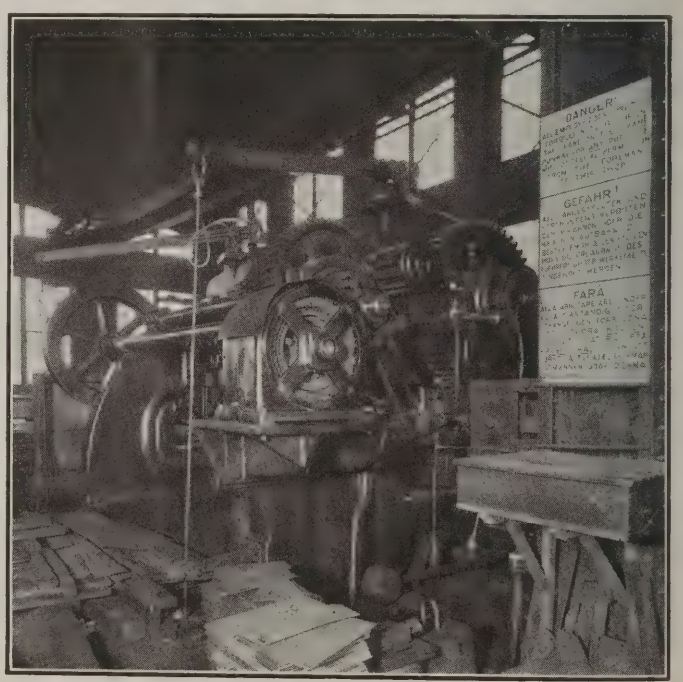
At the Steel Freight Car Shops there is another small electric power plant equipped with two Westinghouse 1,000-kw., 440volt, 60-cycle, 3-phase turbo-generators of the horizontal type. Provision was also made for one steam-driven and two motor-driven exciters and two 500-kw., 220-volt motor generator sets. Most of this direct current will be used for the cranes in various shops. This plant contains two air compressors which have a capacity of 4,000 cubic feet of free air per minute at a pressure of 100 lbs. per square inch. A pump delivers water at a pressure

**LIGHT AND POWER DISTRIBUTION FOR PULLMAN SHOPS FROM CENTRAL ELECTRIC POWER PLANT.**

| Vault | Location | Transformers in Vaults | | Lights. | | | | Motors. | |
|---|---|---|---|---|---|---|---|---|---|
| | | Light | Power | Carbon Inc. | Flame Arc. | Enclosed Arc | 250 Watt Tungsten | No. | Total HP |
| 1 | Shops A and B ..... | 3-75 kva. | ..... | 1008 | 42 | ..... | ... | .... | ..... |
| 2 | Brass-finishing shop..... | 1-40 " | 3-100 kva. | 65 | 36 | ..... | ... | 18 | 475 |
| 3 | Shop No. 6..... | 3-15 " | 3- 50 " | ..... | ..... | ..... | 134 | 10 | 195 |
| 4 | Calumet Shops..... | 3-25 " | 3-100 " | 500 | ..... | ..... | 80 | ... | 300 |
| 5 | Shops No. 4 and No. 5..... | 3-30 " | 6-100 " | 630 | 78 | ..... | ... | ... | 600 |
| 6 | New wood mill..... | 3-50 " | 6-100 " | 700 | ..... | 53 | ... | 32 | 1025 |
| 7 | Old wood mill..... | 3-30 " | 3-100 " | 752 | ..... | 59 | ... | 11 | 340 |
| 8 | Steel car shop..... | 3-20 " | 3-100 " | 60 | 35 | ..... | ... | 42 | 620 |
| 9 | Machine shop..... ... | 3-30 " | 3-100 " | 98 | ..... | 52 | ... | 33 | 540 |
| 10 | Wheel and axle shop..... | 3-30 " | 3- 75 " | ..... | 39 | ..... | ... | 12 | 300 |
| 11 | Freight car shop..... | 3-30 " | 3-175 " | 50 | ..... | 120 | ... | 42 | 820 |
| | | 3-20 " | 3- 40 " | | | | | | |
| | Totals..... | 1105 kva. | 3720 kva. | 3863 | 230 | 284 | 214 | 200 | 5215 hp |


Future Generator #1 1500 K.V.A.
225 K.V.A. Feeder to Steel Car Shops "A" and "B"
340 K.V.A. " to Brass Finishing Shop
195 K.V.A. " to Shop #6, Glass & White Metal Depts.
375 K.V.A. " to Calumet Repair Shops
690 K.V.A " to Passenger Car Shops #4 and #5
750 K.V.A " to New Wood Working Mill
390 K.V.A. " to Old " " "
Bus Sectionalizing Switch
2300 Volt Main Bus
1200 Volt Motor Bus
430 H.P. Synchronous Motor Direct Coupled to a 300 K.W. 250 Volt D.C. Generator
90 H.P. Induction Motor Direct Coupled to a 60 K.W. 125 Volt Exciter
Future Ditto
Motor Starting Trans.
2000 K.V.A. The Line to Power Plant at Steel Freight Car Shops
Trans.
Trans.
Bus Sectionalizing Switch
Generator #2 1500 K.V.A.
30 K.W. Station Lighting Feeder
Trans.
Generator #3 1500 K.V.A.
600 Amp T.P.S.T. Oil Switches
360 K.V.A. Feeder to Steel Passenger Car Shops
390 K.V.A " to Machine and Blacksmith Shops
318 K.V.A. " to Bolt, Wheel and Axle Shops
796 K.V.A. " to Old Freight Car Shops
Feeder #12
" #13
" #14
Future
300 Amp. T.P.S.T. Oil Switches

System of Connection.



Typical Direct Motor Drive in Pullman Shops.

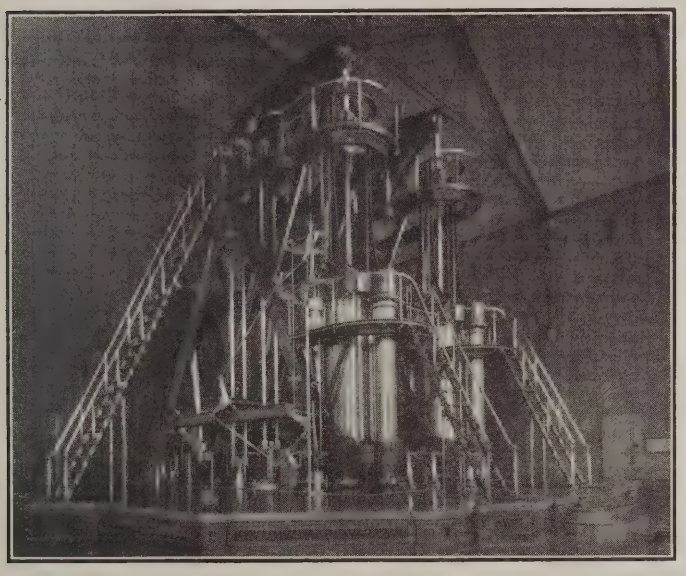
of 1,000 lbs. per square inch to the hydraulic presses in the car and machine shops. This water passes through 1,500 ft. of steel pipe laid in a tunnel. Most of the electric power generated here is transmitted to the passenger car shops through 440/2,300 volt step-up transformers, and a temporary tie line of No. 4 weather proof wire.

### Distribution of Power.

From the main station the power is distributed through underground conduits to 11 transformer vaults in various parts of the yards. The conductors vary in size from No. 4 up to No. 00. The transformer vaults are of concrete with steel reinforced roofs, and with the manhole in one corner.

All buildings are served from the transformer vaults through underground conduits by rubber covered cables. Distribution is shown in detail in the accompanying table. All of the best known makes of transformers are included in the Pullman installation.

About 40 per cent of the motors used are direct-connected to machine-tools. Most of them are 3-phase induction motors. The small machine tools and



"Centennial" Corliss Engine Now Superseded by Electric Power.

most of the wood working tools are driven in groups by large induction motors. Direct current motors are used for the cranes and hoists.

### Steel Freight Car Shop.

The Steel Freight Car Shops consist of three buildings and some sheds. The main building is 400 ft. wide (4 bays of 100 ft. each) by 1,175 ft. long, with a roof composed largely of glass.

These shops contain all necessary equipment for making steel freight cars of all types. They employ 3,000 men when running full. Only a few of the machine tools are as yet in place, these being employed in making steel passenger cars.

The axle shop is located north of the main shop and the power machine building south of it.

### Passenger Car Shops.

In this plant the Passenger Car Shops are, of course, most important. The principal buildings are so placed that transfer tables run between them. These transfer tables are steam driven and are not included in the electrification scheme.

The buildings include steel and wood car building shops, carpentry, machine, brass finishing, foundry, steel and axle shops, store rooms and separate shops for upholstering, pipe-fitting, painting and brass work. There are about 10,000 men employed in the passenger car shops at present.

The capacity of the plant is 150 cars a month, of which half may be all-steel.

### Calumet Repair Shops.

The Calumet repair shops are just south of the passenger shops. These are more strictly comparable with the average railway shops, as it is here that all repairs are made on the cars operated by the Pullman Company. As many as 2,000 men have been employed in these shops during busy seasons. Electric power for their operation is furnished from the central power plant through cables paid in conduit. With the completion of the improved plant, electrical power will be used for practically every purpose in the Pullman plant.

For indoor lighting 250 watt and 500 watt tungsten lamps are being adopted as standard for general illumination, but a liberal use of small incandescent lamps is made. 200 watt and 400 watt series tungsten lamps will be used outdoors. The yard lights are mounted on poles and brackets from the buildings. Three constant current transformers of 300 light capacity each are provided to take care of the outside illumination.

### What Electricity Has Displaced.

No description of the Pullman Car Shops would be complete without some reference to the original mechanical power distribution system in use until recently.

The feature of this system was the underground shafting transmission. This shafting was driven by the old upright Corliss 2-cylinder engine originally exhibited at the Centennial exposition in 1876. It was of the walking beam type. The cylinders were each 40 in. in diameter with 10 ft. stroke. Nominally each cylinder would develop 700 h.p. at 36 r.p.m., giving 1,400 h.p. total. Actually it developed over 2,000 h.p. at times. The engine weighed over 800 tons and was 39 ft. high from the floor to the top of the walking beam. The walking beams were made of cast iron 9 ft. wide in the center and 27 ft. long and weighed 11 tons each. The piston rods were of steel 6¼ in. in diameter and the connecting rods 24 ft. long. The frame was "A" shaped with the journals for the walking beam shafts on top. The fly wheel, 30 ft. in diameter with a 2 ft. face weighed 56 tons, and had gear teeth in the center of the face which meshed with a pinion 10 ft. in diameter weighing 8½ tons. This pinion was mounted on a 14 in. steel shaft below the floor and was the beginning of the underground transmission line.

From this pinion a steel line shafting extended for approximately two miles through a tunnel to all parts of the plant. This shafting ran at 108 r.p.m., transmitting as much as 2,000 h.p. at times. Right angle turns were made by bevel gears 6 ft. in diameter, there being 8 pairs of these altogether. It has been estimated that about 350 h.p. was lost in this underground transmission system, a remarkably small percentage considering the distance.

The turbo-generator sets in the central power plant were built by the Allis-Chalmers Company as were also the exciters and the 250-volt motor-generator set. The switchboard and high tension controlling apparatus was furnished by the Delta-Star Electric Company under contract with the Central Electric Company. The corresponding equipment in the power plant at the steel freight car shops was built by the Westinghouse Electric & Mfg. Co.

# Exhibits at the Railway Appliance Show

**Adams & Westlake Company.**

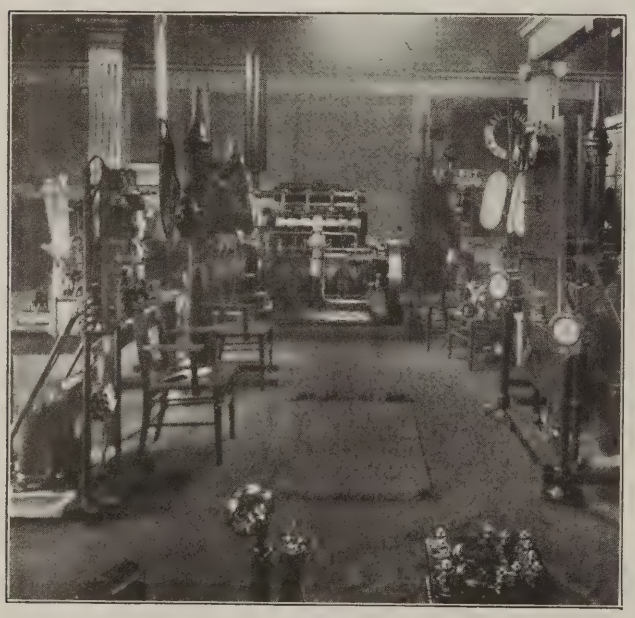
The Adams & Westlake Company exhibited their very complete line of signal lamps, lanterns, etc., and a number of their railway specialties. They were represented by W. H. Baldwin, assistant general manager, G. L. Walters, railway sales manager, A. S. Anderson, C. B. Carson, W. J. Pierson, H. G. Turney, E. H. Stearns and F. N. Grigg.

**Bryant Zinc Company**

Battery supplies, fibre conduit, Gould storage batteries, crossing bells, battery vaults and chutes, electrical instruments, track and linemen's tools, were shown. The Bryant representatives were A. F. Klink, E. M. Deems, R. N. Baker, Stanley Bryant, H. J. Hovey, R. N. Chamberlain and J. W. Cremerius.

**Duplex Metals Company.**

A model of a pole line in a snow storm was the striking feature of this exhibit. The model showed the effects of snow and sleet upon ordinary wires as contrasted with their effect upon "Copper Clad." Samples of various "Copper Clad" products were shown, and a new bulletin, "The Copper Clad Handbook," was distributed. Represented by Frank R. Chambers, Jr., vice-president, Wm. T. Kyle, Geo. P. Fondersmith, W. W. Lampkin, E. M. Fondersmith.



General Electric Company's Exhibit.

**Edison Manufacturing Company.**

This exhibit consisted of primary batteries for all uses to which they are put on railroads, such as signal work, crossing bells, telephone circuits, and gas engine ignition. Representatives: E. E. Hudson, manager of sales, E. J. Lepreau, E. W. Brown and P. A. Garrity.

**Edison Storage Battery Company.**

The Edison Storage Battery in various sizes for signal work, car lighting, and ignition, was shown by this company. The novel construction of the battery, differing as it does from any other storage cell, aroused much interest among visiting railway men. The company was represented by H. G. Thompson, manager railway department.

**General Electric Company.**

The General Electric Company had an exhibit of great interest to all visitors. It included typical devices in use on the railways and no attempt was made to indicate the wide scope of electrical apparatus which the company manufactures. The 4-cycle gas engine set attracted perhaps more attention than any of the other parts of the exhibit. This engine-generator set is one of the finest pieces of machinery ever put together. Originally built to meet the specifications of the United States government for the operation of large coast defense guns, it has proven exceedingly popular with the industrial world and is now being furnished in large quantities to small central stations for carrying the valley load and to railways for the operation of signals and the charging of car lighting batteries. The engine is direct connected to a generator either a. c. or d. c., as may be required, which has a full load capacity of 25 kilowatts, but will take care of a 25 per cent overload for two hours without injury. The self lubricating feature makes it possible for the engine to be in operation for periods of several hours without attention. The governing device will bring the engine back to normal speed in 4 seconds after the circuit breaker blows on full load. The spark is obtained either from batteries or magneto. For quick starting one of the cylinders is fitted to take a 10 gauge brass shotgun shell. This is fired by a pin with a blow of the hand, and when half filled with powder will turn the flywheel through several revolutions and insure quick starting. It is stated that the gasoline consumption of this engine is less than 1.9 pints per kilowatt-hour.

Western Electric Company's Exhibit.

A motor generator set for changing 110 volt direct current to 220 alternating current at 60 cycles was also in operation. A reversal of this operation was shown in a mercury arc rectifier for changing alternating to direct current for battery charging.

In addition to these were complete signal systems of both the a. c. and d. c. types with a variety of auxiliary apparatus, such as relays, battery charging switches, resistance units, etc. One thing of great interest to all electrical men was a pocket meter giving readings of 1 mil-ampere to 15 amperes and 1.5 to 150

volts. This is one of the most compact and useful instruments on the market.

The General Electric Company was represented by Frank Rhea, H. K. Ferguson, F. B. Corey, W. W. Brown, L. A. Hawkins, H. E. Moore, R. E. Russell, H. L. Monroe, C. A. Ives, A. P. Jenks and L. G. Crawford.

**H. W. Johns-Manville Company.**

In addition to various asbestos products this company exhibited such electrical specialties as fuses, "Linolite" lamps, moulded sockets and fibre conduit. Represented by J. W. Meek, J. C. Younglove, F. M. Gilmore, P. C. Jacobs, G. A. Nichol, C. E. Murphy, H. G. Newman, F. W. Doty, W. J. Hennessy, Geo. Christenson and G. W. Gearhart.

**Kerite Insulated Wire & Cable Company.**

As shown in the accompanying illustration, the Kerite Insulated Wire & Cable Company exhibited "Kerite" wires and cables of all sizes for all branches of railway service. A large number of interesting photographs of "Kerite" installations were shown, including those of the new Pennsylvania Terminal in New York. The Kerite representatives were: R. D. Brixey, president, Azel Ames, P. W. Miller and J. A. Renton. The Watson Insulated Wire Company, western representatives, were represented by J. V. Watson, B. L. Winchell, Jr., and E. B. Price.

Exhibit of Kerite Insulated Wire & Cable Company.

**Kellogg Switchboard & Supply Company.**

Railway telephone equipment, including train dispatching sets, various types of portable telephones, siding telephones and ordinary telephones for use on both steam and electric railroads. Intercommunicating sets, composite telephones, insulated telephones and private branch exchanges. Represented by J. C. Kelsey, sales manager; G. A. Joy, sales engineer; Archibald Wray, railway telephone engineer, and Wm. Booth, city salesman.

**W. N. Mathews & Brother.**

Mathews' guy anchors, cable clamps, cable splicing joints and "Holdfast" fool-proof lamp guards. Represented by Claude L. Mathews, W. N. Mathews, Victor L. Crawford, Walter E. Bischoff and A. P. Eckert.

**Geo. P. Nichols & Bro.**

Full sized model of an electric turntable tractor. Represented by Geo. P. Nichols, S. F. Nichols and Henry Fries.

**Okonite Company.**

Okonite wires and cables for all kinds and conditions of electrical service. Potheads, cable joints, Okonite and Manson tapes and Lorenz channel pins for rail connections. Represented by Messrs. Langan and Martin, of New York, and J. M. Lorenz, E. M. Cox and C. E. Kacin, of the Central Electric Company, Chicago.

**Sandwich Electric Company.**

The Sandwich train announcer, a selective ringing and signal device for use in controlling trains entering terminal stations, and Sandwich selectors for telephone train dispatching. Represented by E. C. Hennis.

**Standard Underground Cable Company.**

Bare and insulated copper wires for all purposes. Bare and insulated copper-clad wires. Represented by H. P. Kimball, R. G. Harris, E. J. Pietker, Russell E. Green and B. S. Stewart.

**United States Electric Company.**

Gill selectors for railway telephone and telegraph work. Electrical control of semaphores from dispatcher's office. Represented by W. L. Cook, Edw. E. Backus and M. E. Launbranch.

**Western Electric Company**

The exhibit of the Western Electric Company, presided over by Geo. H. Porter, included the following: Sunbeam Mazda train lighting lamps, Western Electric telephone train dispatching equipment, Habirshaw wires and cable, Faraday crossing bells, Blue Bell batteries, Selective siding semaphore, Paragon ground cones, Western Electric interphones.

The company was represented at the show by Geo. H. Porter, D. C. Guest, M. A. Oberlander, G. K. Heyer, W. H. Doherty, H. L. Grant and Mr. Finley.

## ELECTRIC FIRE PROTECTION.

The International Electric Protection Company has just issued a very interesting bulletin on the different patents controlled by this company covering electric devices protective against fire, and their application to such large buildings as railway terminals. The patents apply to both alarm and sprinkler systems and it is claimed for them that they are much more quick to act than the devices hitherto used.

# Railway Telephony*

GREGORY BROWN

Railway telephone service is classified into:

1. Train despatching.
2. Messenger service.
3. Block wire service.

The requirements are:

1. Ability to signal any one of 50 or more stations on a 250 mile (402-km.) line and ability to signal despatcher from any of the stations.

2. Arrangements whereby any number of stations can simultaneously listen in.

3. Means of quickly testing and patching any portion of the circuit which gets into trouble.

Additional advantages of the telephone:

a. Provision whereby officials who are not telegraph operators, but who are directly interested in the movement of traffic, as for instance, train masters, yard masters, division superintendents, etc., can listen on the wire and keep in touch with traffic conditions.

b. Arrangements permitting the signaling of stations without interrupting conversation. This feature results in saving a considerable amount of time.

c. Automatic notification to the dispatcher that the station he is calling is receiving the signal.

### Signaling.

The three general types of selectors which have been developed for this purpose are:

1. Instruments responding only to a certain number and sequence of long and short current impulses or

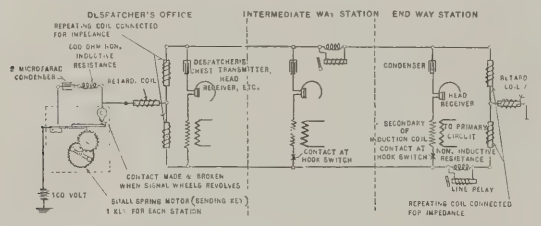



Fig. 1.—Diagram of First Line Circuits Using Selectors.

long and short intervals between impulses. In this case the only instrument on the line that would function properly and close its contact would be the one which was adjusted to respond to the particular code arrangement of impulses which were being impressed on the line.

2. Instruments arranged to be started simultaneously by the despatcher and to operate independently but in synchronism with each other by means of local energy at the station. The despatcher's sending device being so arranged that at a predetermined instant one impulse is sent out on the line which at this instant is provided with a path through one selector contact only, the other selectors either having passed their contacts or not having reached them.

3. Instruments of the so-called step-by-step type which are stepped around in synchronism by a succession of impulses from the despatcher's office, the number of impulses sent determining the station called.

### The Gill Selector.

What is known as the Gill selector is an instrument of the first or code impulse type. This device has been used for a number of years to selectively signal telegraph offices, and for this service it is connected in series with the back contact of the telegraph relay and battery. When the proper code is sent over the line, the selector will function and ring the bell, but by using ordinary Morse characters it is practically impossible to reproduce the code and falsely call. As this selector had been pretty well tried out for telegraph service, it was but natural that it should be one of the first used with the telephone. It consists essentially of a ratchet wheel, an electromagnet whose armature is arranged to step the wheel forward, a retaining pawl to retain the teeth stepped and a mechanical time element whose function it is to permit the retaining pawl to assume either one of two positions, according to the length of the impulse of current.

The time element consists of a metal wheel fastened to a small diameter shaft so arranged that it can roll down an inclined rod.

The fact that it is the small diameter shaft of the comparatively large wheel, that rolls down the incline causes the descent to take an appreciable time. When the stepping arm is in its upper position it prevents the wheel from descending, but when it moves to the lower position due to current, the wheel starts to roll and will reach its lower limiting position provided the current impulse is of long enough duration. If, however, the impulse is short, the stepping arm will return to its upper position due to the retractile spring, and prevent the wheel from descending its full distance. It will thus be seen that a long impulse permits the time element to function while a short impulse does not.

In the first installations of this type of apparatus the line circuit arrangement was as shown in Fig. 1. It was thought advisable to use a line relay at every station and operate the selectors and bells by local battery. In order that the sending impulses might not introduce enough noise in the receiver bridges to interfere with conversation while the despatcher was signaling, and also to permit each line relay to receive the same amount of current, a grounded simplexing arrangement was used for signaling, the relays being placed in series with the line. Relays at alternate stations were connected in opposite sides of the line, so as to maintain balance as nearly as possible. With ordinary relays placed in series, the transmission loss would, of course, be very considerable. The relays used therefore on the first installations were of a sensitive type having an inductive winding of 20 ohms and a non-inductive shunt of 30 ohms. This was, in fact, a type of telephone supervisory relay, and from a transmission standpoint was the most efficient relay available. Although the transmission loss in the relay was reduced to a minimum, it was still appreciable especially on a long line with many stations and several receivers off the hook. In addition to this, the shunt winding of the relay made a very inefficient arrangement for operation, as, of course, the signaling current going through the non-inductive shunt represented a clear waste. Another objection to this circuit that was found in practice was

*Abstract of paper presented before the Pacific Coast meeting of the American Institute of Electrical Engineers, Los Angeles, April 25th, 1911.

noise introduced from the grounds and unbalance, as it is almost impossible to balance the line with series relays. Also the effect of lighting on the series arrangement was found to be rather disastrous.

The troubles experienced with this circuit finally led to the development of a new circuit, as shown in Fig. 2. In this arrangement there are no grounds on the line and no line relays used. The selectors are wound to 4,500 ohms resistance and placed directly across the line. In series with the selectors is placed the proper amount of tapering resistance, so that the

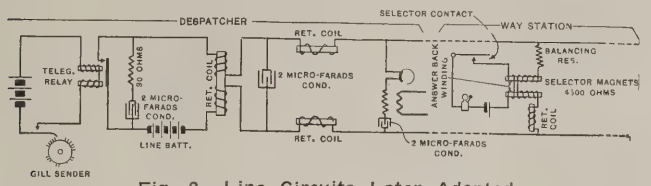



Fig. 2.—Line Circuits Later Adopted.

amount of signaling current through each bridge will be the same.

The answer back is obtained by including, in series with the selector contact bell and battery, a secondary winding on the spools of the selector. As the bell vibrates it induces current in the selector windings which produces a tone in the despatcher's receiver. With this circuit arrangement the normal current for the operation of the selectors is ten milliamperes. The current, however, can fall considerably below this without affecting the operation of the selectors. The retardation coils and condensers at the despatcher's end of the line are used to cut down the peak of the current wave to such a point that the noise in the receivers while the signal is being sent is not enough to interfere with conversation. In this circuit it is necessary to introduce a condenser in series with the receivers across the line in order that the signaling current may not be shunted through the talking bridges.

### The Wray-Cummings Selector.

The second type of selector which has been extensively used, that is, selectors maintained in synchronism by local energy at the substation, is what is known as the Wray-Cummings selector. The master selector consists of a standard clockwork mechanism,

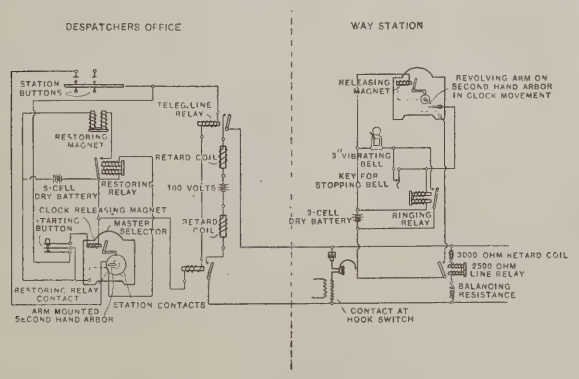



Fig. 3.—Wray-Cummings Selector Circuits.

to the second hand of which is attached a contact arm. In the path of this contact there are thirty insulated segments which are arranged so that any one of them can close battery current through a relay when the contact arm engages with this particular segment. This mechanism is merely a retardation device arranged so that when operated a contact is made for a length of time sufficient to operate the relays which start the master and all the station clocks. The substation selector is similar to the despatcher's clock mechanism except that each station is equipped with but one contact arranged to engage with the revolving arm. These contacts at the various stations are adjusted at different angular displacements from the normal position of the contact arm. When the despatcher has started all the clocks simultaneously, it is evident that the contact arm on the master selector will have reached, say, its tenth point at the same instant that the tenth selector has reached its point. At this instant there are no other selectors which are on their contact point and due to the fact that the tenth point on the despatcher's clock is connected by means of a locked push button to cause current to flow on the line, the signaling mechanism at the desired station will be operated. Fig. 3 shows the circuit arrangement at the despatcher's office and at the way-station.

### Western Electric Selector.

The third class, or step-by-step selector, is represented by the Western Electric selector. This device consists of two electromagnets connected in series and mounted in a brass frame. Each magnet is equipped with two spools, the cores of one of the magnets being covered with copper sleeves to produce slow action. This selector is operated by first placing on

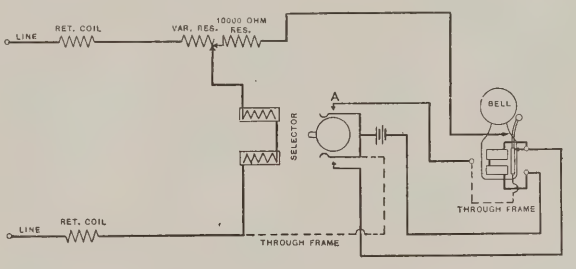



Fig. 4.—Local Battery Way Station Circuit.

the line an impulse of current which operates both magnets. There is then placed on the line a succession of short impulses, which cause the stepping magnet to oscillate back and forth and step the wheel around the desired number of steps. The speed with which these impulses are placed upon the line, however, does not permit of the slow-acting magnet releasing. When the desired number of steps are taken, the contact is made and current is held on the line, thus ringing the bell.

As soon as current is removed from the line the slow-acting magnet releases, which raises the pawls and permits the wheel to fall back to normal position under the influence of its retractile spring. When a station is called, say, for instance, No. 10, all the selectors take ten steps and the selectors at the first nine stations will momentarily make their contacts as they step around; thus momentarily the local station battery circuit is closed at these stations. This, however, will not cause the bell to ring for the following reason: The selector operates at the rate of 8 to 10 steps per second, and the arrangement of the contact spring is such that it follows the movement of the stepping lever and during a stepping cycle makes contact with the contact arm in but a small percentage of a false signal being given.

Fig. 4 shows the local battery way-station circuit used with this selector. There are 40-ohm retardation coils placed on either side of the selector as a protection against lighting. The selector is wound to 3,750 ohms and is connected with the proper taper re-

(Concluded on page 12)

# Telephone and Telegraph Train Dispatching

Condensation of report compiled by the Block Signal and Train Control Board of the Interstate Commerce Commission.

Including all roads which have over 100 miles of Telephone Train Dispatching Circuits.

| Name of Railroad. | Telegraph Miles of Road | Telephone Miles of Road | Total Miles Operated |
|---|---|---|---|
| Arizona & New Mexico | 108 | 108 | 108 |
| Atchison, Topeka & Santa Fe | 5,448 | 3,884 | 9,332 |
| Atlantic Coast Line | 3,672 | 376 | 4,048 |
| Boston & Maine | 1,994 | 232 | 2,239 |
| Buffalo & Lake Erie | | 101 | 101 |
| Chicago & North-Western | 7,003 | 743 | 7,746 |
| Chicago, Burlington & Quincy | 6,439 | 2,383 | 9,040 |
| Chicago, Milwaukee & St. Paul | 6,233 | 1,044 | 7,277 |
| Chicago, Milwaukee & Puget Sound | 1,077 | 726 | 1,803 |
| Chicago, Rock Island & Pacific | 4,674 | 2,248 | 6,922 |
| Cumberland Valley | | 162 | 162 |
| Detroit United | | 135 | 135 |
| Erie | 1,981 | 175 | 2,156 |
| Evansville & Terre Haute | 66 | 109 | 175 |
| Fort Dodge, Des Moines & Southern* | | 159 | 159 |
| Fort Wayne & Wabash Valley Traction* | | 139 | 139 |
| Georgia | 58 | 245 | 303 |
| Great Northern | 3,224 | 3,881 | 6,905 |
| Illinois Central | 2,531 | 2,550 | 4,581 |
| Illinois Traction* | | 415 | 415 |
| Indiana Union Traction* | | 313 | 313 |
| Lehigh Valley | 743 | 643 | 1,386 |
| Louisville & Nashville | 3,388 | 498 | 3,884 |
| Macon & Birmingham | 105 | 105 | 105 |
| Minneapolis, St. Paul & Sault Ste. Marie | 3,518 | 190 | 3,708 |
| Missouri Pacific (Inc. St. L., I. M. & S.) | 6,863 | 247 | 7,038 |
| New York Central Lines: | | | |
| Boston & Albany | 88 | 278 | 336 |
| Chicago, Indiana & Southern | 110 | 216 | 326 |
| Cleveland, Cincinnati, Chicago & St. Louis | 1,145 | 704 | 1,849 |
| Lake Erie & Western | 872 | 571 | 872 |
| Lake Shore & Michigan Southern | 793 | 770 | 1,563 |
| Michigan Central | 545 | 714 | 1,259 |
| New York Central & Hudson River | 2,388 | 521 | 2,909 |
| New York, Chicago & St. Louis | 391 | 132 | 523 |
| New York, New Haven & Hartford | 1,879 | 184 | 2,063 |
| Norfolk & Western | 752 | 1,066 | 1,818 |
| Norfolk Southern | 519 | 222 | 565 |
| Northern Pacific | 4,469 | 1,190 | 5,659 |
| Northwestern Pacific | 215 | 112 | 327 |
| Pacific Electric* | | 503 | 503 |
| Pennsylvania | 1,856 | 1,734 | 3,541 |
| Philadelphia, Baltimore & Washington | 1,235 | 107 | 1,342 |
| Pere Marquette | 1,515 | 138 | 1,651 |
| St. Louis & San Francisco | 4,187 | 835 | 5,022 |
| Seaboard Air Line | 2,625 | 421 | 3,046 |
| Southern | 6,916 | 123 | 7,039 |
| Southern Pacific System | 8,833 | 1,177 | 10,195 |
| Tremont & Gulf | | 124 | 124 |
| Union Pacific (Inc. O. S. L.) | 4,327 | 654 | 4,982 |
| Virginian | | 467 | 467 |
| Western Ohio* | | 111 | 111 |
| | 104,785 | 34,885 | 138,272 |

*Electric.

The difference between the sums of the footings of the first two columns, 139,670, and that of the third column, 138,272, shows that both the telephone and the telegraph are used for train dispatching on only 1,396 miles of road. This means that the telephone has entirely replaced the telegraph on many miles of line.

The grand totals of all the railways in the United States (all having less than 100 miles of telephone dispatching are omitted from the above condensed table) show:

| | |
|---|---|
| Telegraph (Miles of Road) | 175,211 |
| Telephone (Miles of Road) | 41,717 |
| Total Miles Operated | 215,003 |

Telephones were used for train dispatching on 20 per cent of the railway mileage of the United States on Jan. 1. 1911. It is safe to predict that at least 10,000 miles of circuits will be added this year.

# The Dope Sheet

## CAR LIGHTING EQUIPMENT, COST OF

HEAD END BOOSTER SYSTEM

Cost of Equipping 20 Passenger Cars in Local Service for Electric Lighting.

| ITEM | 20 Cars | Av. Cost Per Car |
|---|---|---|
| Labor | $ 3,599.70 | $ 179.98 |
| Shop Expenses | 737.03 | 36.85 |
| Store Expenses | 110.34 | 5.52 |
| Lumber | 404.07 | 20.20 |
| Wire, Rubber Covered | 3,300.96 | 165.04 |
| Wire, Insulated | 452.02 | 22.60 |
| Conduit | 549.13 | 27.45 |
| Tape, Cord, etc | 72.02 | 3.60 |
| Connectors, Train Line and Loop | 2,490.00 | 124.50 |
| Automatic Switches | 1,200.00 | 60.00 |
| Switchboards | 281.20 | 14.06 |
| Fuses and Fuse Boxes | 101.32 | 5.06 |
| Junction Boxes and Connectors | 291.51 | 14.58 |
| Fixtures, Receptacles, etc | 847.61 | 42.38 |
| Paint and Varnish | 90.54 | 4.52 |
| Miscellaneous Hardware | 486.13 | 24.30 |
| Storage Batteries, Complete, 32 cells per car, 280 ampere hour capacity, in 16-compartment lead-lined tanks | 14,718.24 | 735.91 |
| Total | $ 29,731.82 | $ 1,486.59 |

## WOOD WORKING MACHINERY, POWER TO DRIVE

| Name of Tool | Nature or Material | R. P. M. Driving Shaft | R. P. M. Tool | Cut | Cu. In. P. Sec. | Horse Power No. | Load | Max. | Av. | Useful H. P. Av. |
|---|---|---|---|---|---|---|---|---|---|---|
| Grinding Machine | Grinding | | | | | 0.6 | | 4.40 | 3.45 | 2.85 |
| Planer Knife & Grinder | Running Light | 580 | | | | 0.55 | | | | |
| Turning Lathe | Turning Oak 8″x8″ | | | | | | | | | |
| Line Shafting (1) | | 264 | | | | 0.55 | | 2.10 | 1.52 | 0.97 |
| Line Shafting (2) | | 261 | | | | 7.60 | | | | |
| Main Line Shafting | | | | | | 4.60 | | | | |
| 6 Buffing Lathes | Running Light | | | | | 7.80 | | | | |
| | Working | | | | | 7.25 | | | | |
| | 1 Lathe Working | | | | | 7.25 | | 19.1 | 11.9 | 4.65 |
| No. 5 Fan (Sturtevant) | | | 2140 | | | 7.25 | | 9.5 | 8.9 | 1.65 |
| | Running Light | 905 | | | | 10.4 | | | 7.8 | |
| Flooring Machine | Yellow Pine | 1000 | | 6″x5⅛″ 1¼″x½″ | 50.0 | 10.4 | | 33.2 | 24.5 | 14.1 |
| | Yellow Pine | 900 | | 7¼″x½″ | 39.8 | 10.4 | | 22.0 | 19.3 | 8.9 |
| | Yellow Pine | 900 | | 6″x3⅜″ 1¼″x½″ | 26.4 | 10.4 | | 21.3 | 19.0 | 8.6 |
| | Yellow Pine | 905 | | 8″x1¼″ 1¼″x½″ | 24.5 | 10.4 | | 30.5 | 25.2 | 14.8 |
| | Running Light | 535 | | | | 1.9 | | | | |
| Three Spindle | Boring Freight | | | | | 1.9 | | | | |
| Boring Machine | Car End Sill | | | | | | | | | |
| | Countersinking | | | | | 1.9 | | 7.15 | 5.9 | 4.0 |
| Four Spindle Horizontal Boring Machine | Running Light | | | | | 1.9 | | 7.65 | 6.5 | 4.6 |
| | Oak | 1750 | | 2⅝″x7½″ Hole | | 7.15 | | 14.9 | 12.6 | 5.5 |
| | Oak | 2030 | | 2 1/16″x9 ″ Hole | | 7.15 | | 14.0 | 12.6 | 5.5 |
| | Oak | 2030 | | 1 1/16″x10 ″ Hole | | 7.15 | | 11.6 | 10.4 | 3.2 |
| | Oak | 2030 | | 1 1/16″x10 ″ Hole | | 7.15 | | 17.2 | 12.6 | 5.5 |

From actual tests in a large railway shop.

## CAR LIGHTING EQUIPMENT, COST OF

HEAD END BOOSTER SYSTEM

Cost of Equipping 6 Locomotives and 6 Locomotive Tenders for Electric Lighting of Local Passenger Trains

| ITEM | 6 Locomotives | 6 Tenders | Av. Per Loco. | Av. Per Tender | Av. Loco. and Tender |
|---|---|---|---|---|---|
| Labor | $ 524.31 | $ 368.97 | $ 87.40 | $ 61.49 | $ 148.89 |
| Shop Expenses | 146.22 | 90.97 | 24.37 | 15.16 | 39.53 |
| Store Expenses | 66.93 | 17.57 | 11.15 | 2.94 | 14.09 |
| Conduit | 113.40 | 65.10 | 18.90 | 10.85 | 29.75 |
| 15 Kilowatt Turbines | 8,250.00 | ..... | 1,375.00 | ..... | 1,375.00 |
| Boosters | ..... | 4,950.00 | ..... | 825.00 | 825.00 |
| Automatic Switches | ..... | 450.00 | ..... | 75.00 | 75.00 |
| Connectors | ..... | 360.00 | ..... | 60.00 | 60.00 |
| Miscellaneous Hardware | 184.73 | 65.74 | 30.78 | 10.95 | 41.73 |
| Total | $ 9,285.59 | $ 6,368.35 | $ 1,547.60 | $ 1,061.39 | $ 2,608.99 |

Taking the total cost of the equipment on cars, locomotives and tenders (which is all used for lighting the cars) we have:

| | |
|---|---|
| 20 Cars | $ 29,731.82 |
| 6 Locomotives | 9,285.59 |
| 6 Tenders | 6,368.35 |
| Total | $ 45,385.76 |
| Per Car | 2,269.28 |

## WOOD WORKING MACHINERY, POWER TO DRIVE

| Name of Tool | Nature or Material | R. P. M. Driving Shaft | R. P. M. Tool | Cut | Cu. In. P. Sec. | Horse Power No. | Load | Max. | Av. | Useful H. P. Av. |
|---|---|---|---|---|---|---|---|---|---|---|
| Hollow Chisel Mortising Machine | Running Light | 850 | | | | 3.7 | | | | |
| | Oak | | | 1¾″x2″ | 4.43 | 3.7 | | 14.5 | 11.9 | 8.2 |
| Sash Mortising Machine | Running Light | 520 | | | | 0.75 | | | | |
| | Yellow Pine | | | ¾″x2½″ Deep | | 0.75 | | 1.5 | 1.4 | 0.65 |
| | Oak | | | ¾″x2 ″ Deep | 0.5 | 0.75 | | 1.65 | 1.35 | 0.60 |
| End Tenoning Machine | Running Light | 780 | 2350 | | | 2.2 | | | | |
| | Oak | | | 7″x3″ Cut | 3.99 | 2.2 | | 11.3 | 9.10 | 6.9 |
| | Oak | | | 7″x3″ Cut | 3.63 | 2.2 | | 12.1 | 8.30 | 6.1 |
| Tenoning Machine | Running Light | 900 | 2650 | | | 1.9 | | | | |
| | Oak | | and | | 1.24 | 1.9 | | 3.6 | 3.25 | 1.35 |
| | Oak | | 2550 | | 2.84 | 1.9 | | 3.6 | 3.25 | 1.35 |
| Tenoning Machine | Running Light | | | | | 4.9 | | | | |
| | Oak | | | 3¾″x6¾″ | 1.35 | 4.9 | | 10.8 | 5.7 | 0.8 |
| Gaining Machine | Running Light | 750 | 2200 | | | 2.15 | | | | |
| | Oak | | | 2¼″x2″ | 11.6 | 2.15 | | 18.1 | 13.9 | 11.7 |
| Shaping Machine | One Head Running Light | 8.30 | | | | 2.0 | | | | |
| Double Head | Two Saw Cuts | | | 1 1/64″x1 1/16″ | 6.66 | 2.0 | | 6.15 | 5.0 | 3.0 |

From actual tests in a large railway shop.

# General News and Personal Mention

## C. R. GILMAN ADDRESSES I. E. S.

Mr. C. R. Gilman, chief electrician, C., M. & St. P. railroad, presented a paper on "Electric Car Lighting" before the Chicago section of the Illuminating Engineering Society on April 20.

Mr. Gilman dealt chiefly with the head-end system of lighting in use on his road. He said the use of shades was, from the illuminating engineer's standpoint, the greatest improvement which has been made in electric car lighting during the past year. He described the changes which have been made possible by the development of the high-efficiency, low-voltage tungsten lamps. On the Pioneer Limited the watts per square foot were reduced from 8.45 to 2.65, 1,512 8 cp. tungstens replacing twice as many 16 cp. carbon lamps. In this case the same dynamo was used, the voltage of the machine being reduced from 110 to 64, as described in the RAILWAY ELECTRICAL ENGINEER of June, 1910.

For mail car lighting steel reflectors with tungsten lamps have proved entirely satisfactory. An important consideration in the selection of shades for railway service is the ease with which they may be cleaned.

Mr. Gilman said that committees of the Association of Railway Electrical Enginers are engaged in settling many of the disputed points, and that the work of standardization was proceeding as rapidly as could be expected. A standard of good illumination is something much to be desired.

The paper was freely illustrated by photographs and test diagrams.

In the discussion which followed, Mr. A. J. Sweet said that there were three lines which improvement in lighting could follow: (1) Reduction of wattage, or increase of luminous efficiency, (2) standardization, (3) artistic development and lessening of glare. He advocated the universal use of the horizontal plane for measurement of illumination, saying that it affords the only reasonable basis for comparisons.

Mr. C. A. Howe, well known in railway electrical circles in Chicago as manager of the office of the Holophane company in that city, has been made general manager of the Holophane Company, Ltd., of Toronto, Canada.

The Kerite Insulated Wire and Cable Company has established a Chicago office in the Peoples Gas Building. This company was formerly represented by the Watson Insulated Wire Company. B. L. Winchell, Jr., is in charge of the new office.

## THE LARGEST STORAGE BATTERY IN THE WORLD.

A contract has just been made by the Consolidated Gas, Electric Light & Power Co. of Baltimore, Md., with the Electric Storage Battery Co. of Philadelphia, Pa., for the installation of an enormous battery to be used for emergency service.

This battery will consist of 152 cells of the "Exide" type, each cell containing 133 plates. Each of the 152 lead lined wood tanks will measure 4 ft. 2 in. in height, 21¾ in. wide and 6 ft. 6⅞ in. long, and will weigh without plates or electrolyte 940 lbs. The total weight of the entire battery equipped with plates and electrolyte, when ready for service will be approximately 1,079,200 lbs.

This battery when fully charged will supply sufficient electric current to light 120,000 twenty-five watt Tungsten lamps for one hour or 240,000 such lamps for twenty minutes, having an output of 4000 H. P.

These huge emergency or "standby" storage batteries are used by the large electric lighting companies to provide for unusual demands for current, caused sometimes by a temporary accident to electric generating machinery, or by sudden darkness preceding a thunderstorm, or as recently experienced in New York City, by a heavy snowfall which within ten minutes increased the demand for current on the New York Edison Co.'s system from 100,000 H. P. to 166,000 H. P. In this case the rate of increase in current was so rapid that it was impossible to connect additional generators with sufficient rapidity, and the storage batteries were called upon to meet the emergency, thus saving New York City from darkness.

## GENERAL ELECTRIC BULLETINS.

Bulletin No. 4817, issued by the General Electric Company, describes that company's 75 h. p. direct current commutating pole railway motor which represents the latest construction in this class of apparatus.

For the purpose of enabling a customer to select the motor best suited to his needs, the General Electric Company furnishes a form for the customer to fill out and return for the purpose of showing the character of the service which it is desired to operate. This information will enable the company to make recommendations. A sample form is included in this bulletin.

In Bulletin No. 4815 are illustrated and described continuous and alternating current motors, and apparatus for controlling them when applied to machine tool operation. The publication contains also illustrations of the motors installed on drills, saws, shapers, milling machines, slotters, planers, lathes, etc.

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A very enjoyable smoker was given in Chicago at the rooms of the Western Society of Engineers on Monday evening, March 20, by the Electric Storage Battery Co.

An interesting paper was read by Mr. H. M. Beck, one of the engineers of the company. Mr. Beck described the recent developments made in storage batteries, also calling attention to the new "Ironclad-Exide" vehicle battery which has been recently placed upon the market by the Electric Storage Battery Co. The talk was illustrated by lantern slides, which added very much to the interest in the subject.

A large number of railway signal and electrical engineers were present, due to the fact that the meeting of the Signal Association was being held in Chicago at this time. After Mr. Beck had finished his paper a general discussion was held, and following it a supper was served.

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The Delta Star Electric Company, Chicago, Ill., are distributing bulletins descriptive of their automatic and non-automatic train connectors, which conform to the recommendations of the Association of Railway Electrical Engineers. Copies of same will be sent upon request.

# Axle Electric Car Lighting

## *A Discussion of Weight*

In the selection of a car lighting equipment, the two most important considerations are COST OF OPERATION and RELIABILITY.

The COST OF OPERATION in the case of an axle generator—storage battery system—consists partly of the cost of hauling and driving the equipment.

The cost of hauling is reduced by the use of light batteries.

The cost of driving is reduced by the use of efficient batteries.

The lead battery, although heavier than the nickel, is so much more efficient that the net saving in hauling and driving is decidedly in favor of the lead battery.

**The United States Light and Heating Company** manufactures efficient batteries which are, of necessity, lead batteries.

So much for **Cost of Operation.**

The **Reliability** of the Bliss System of axle generator in connection with "National" Lead Storage Batteries is demonstrated by the fact that more U. S. equipments are going into car lighting service than of all other makes combined.

**The United States Light and Heating Company**

**General Offices: 30 Church St., New York**

SALES OFFICES AND DEPOTS

NEW YORK BUFFALO CHICAGO DETROIT CLEVELAND ST. LOUIS BOSTON SAN FRANCISCO

(*Continued from page 255*)

sistance to produce equal current in all the bridges. When a station is called, contact A is made, which closes the local battery through the vibrating bell. The bell is also equipped with a front contact which makes and breaks a 10,000-ohm resistance across the line and gives the despatcher an answer back.

This selector is also arranged to ring a bell by means of the battery located at the despatcher's office,

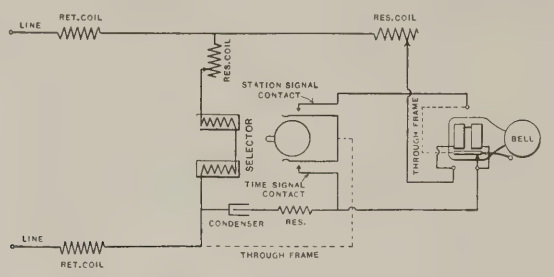


Fig. 5.—Circuit with Batteries at Dispatcher's Office.

thus eliminating the local battery at the substation. Fig. 5 shows the apparatus so arranged. When using central battery to ring the bell it is necessary, of course, to have it high wound. In this case, its resistance is 1,100 ohms and a taper resistance is used in series to produce the same current through the bell wherever it may be located on the line. It was found that if the taper resistance used for the selector was also used for the bell, the drop in voltage due to the combined current passing through the resistance was great enough to reduce the current to an objectionable extent. Separate taper resistances are, therefore, used on the bell circuit. Fig. 6 shows the despatcher's and line circuit.

In addition to the selectors described there are polarized types employing current of one polarity for stepping and of the opposite polarity for ringing. Due to liability of reversing line for repairs, etc., this type has not been successful, and is not in use to any extent.

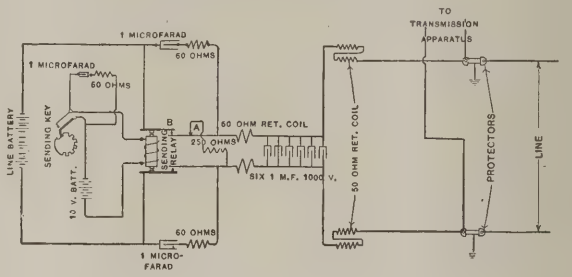


Fig. 6.—Dispatcher's and Line Circuit.

(An abstract of the remainder of Mr. Brown's paper, which covers Message Circuits and Block Circuits, will be published in the June issue.)

# Association Directory.

## ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.

**Secretary's Office.....323 Kinzie St., Chicago.**

The next convention of the Association will be held in Washington, D. C., June 15th and 16th, 1911. The Annual Convention will be held at the La Salle Hotel, Chicago, Nov. 6-10, inclusive.

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D. McK. Hepburn, Niagara Falls Lead & Battery Co.
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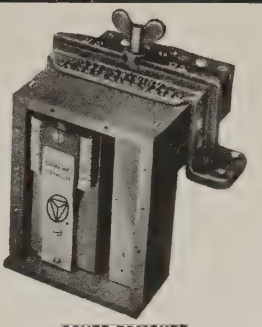

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This is what is done in the

# Railway Shop Series

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## The Shops to be Described

THE shops will be described in the order given below. The shops of the Pullman Company are given first place because their output is familiar to the greatest proportion of our readers, and because they offer an excellent comparison between the old methods and the new.

The series:

May, 1911—The Pullman Company.
June, 1911—C. & N.-W. Railway.
July, 1911—C. M. & St. P. Railway.
Aug., 1911—Illinois Central Railway.
Sept., 1911—A. T. & S. F. Railway.
Oct., 1911—C. R. I. & Pac. Railway.
Nov., 1911—Southern Pacific Railway.
Dec., 1911—Pennsylvania Railroad.
Jan., 1912—L. S. & M. S. Railway.
Feb., 1912—Lehigh Valley Railroad.
March, 1912—Union Pacific Railroad.
April, 1912—N. Y. C. & H. R. Ry.
May, 1912—Summary, Comparisons and Conclusions.

## The Method to be Pursued

EACH article will follow the same general outline in order that comparisons between various parts of various shops can readily be made. This will also have the advantage of allowing the reader to pick out at a glance the particular portions in which he is most interested.

The outline is as follows:

1. General Layout of Shops.
2. Power House and Distribution System.
3. Locomotive Shop.
4. Freight Car Shop.
5. Passenger Car and Paint Shops.
6. Blacksmith Shop and Foundry.
7. Planing Mill.
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9. Yards and Lights.
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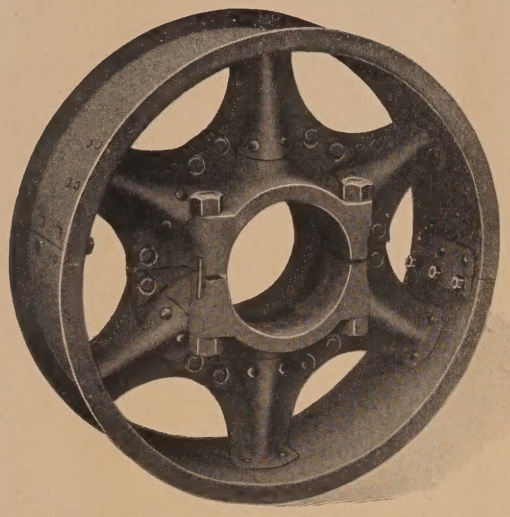

The "ONEIDA" Steel Pulley for car lighting purposes is the best, without a doubt, ever built for that work.

Light, strong, meets every requirement.

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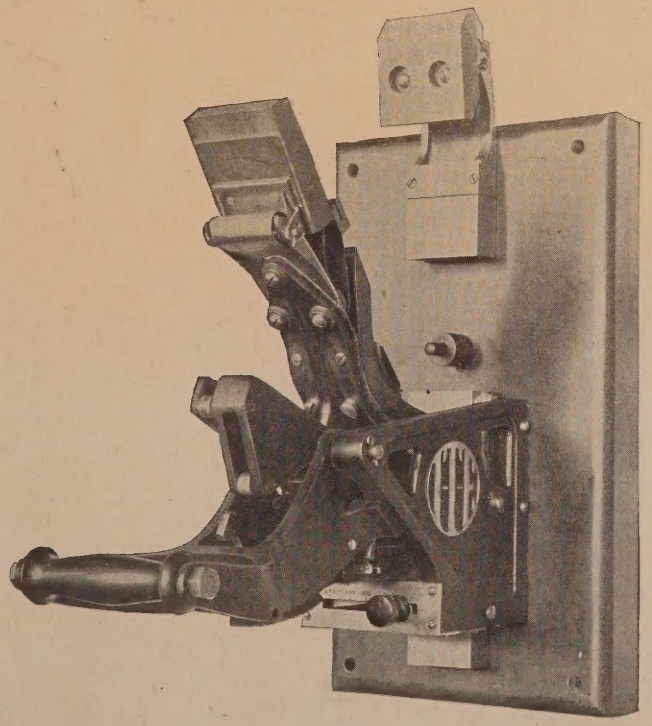
## Oneida Steel Pulley Co.

ONEIDA, N. Y.

# AUTO-I-T-E Circuit Breaker



Non-closable on Overload Circuit Breakers which will not permit being held in closed position against overload or short circuit, are being more universally used as they are fool-proof against the abuse of careless operators.

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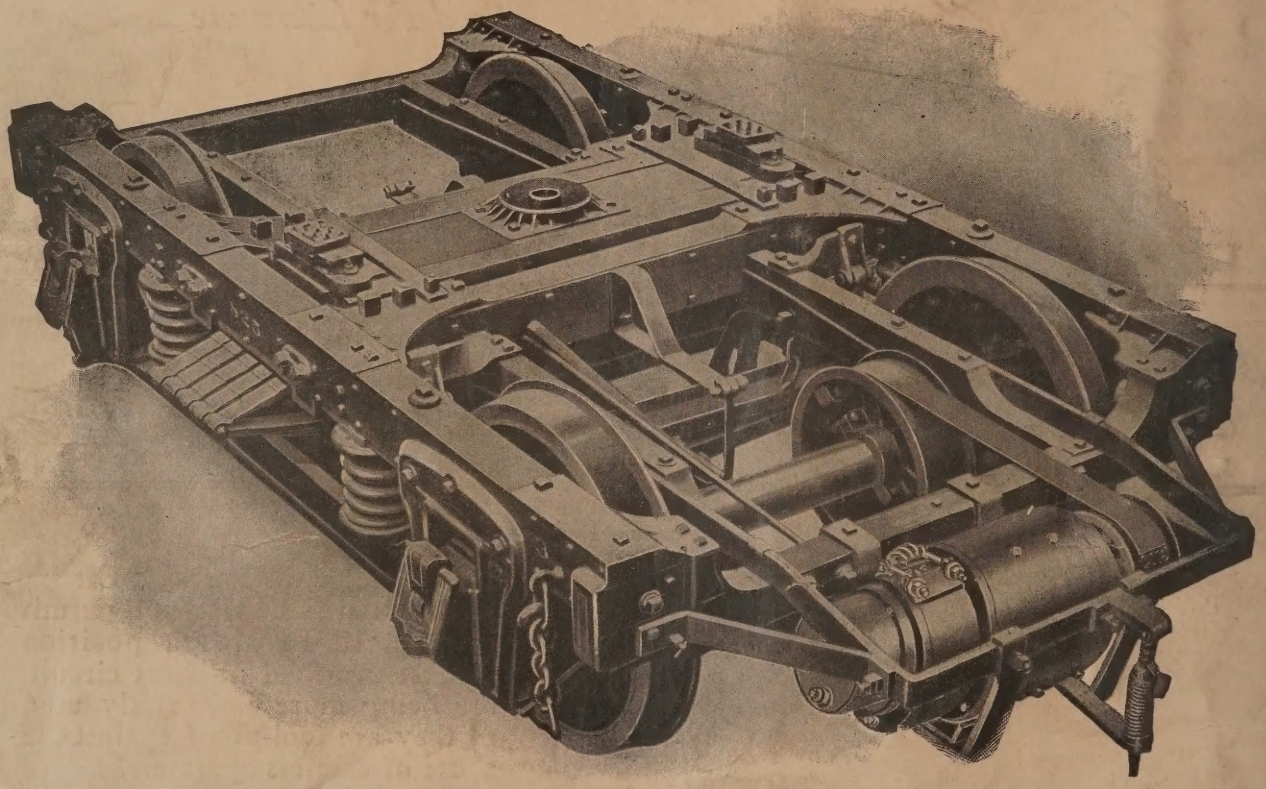

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